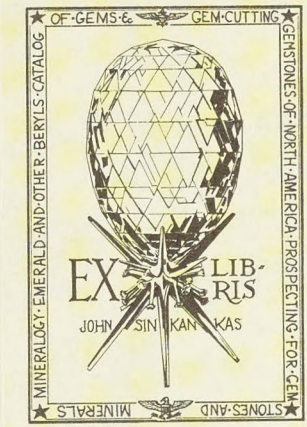
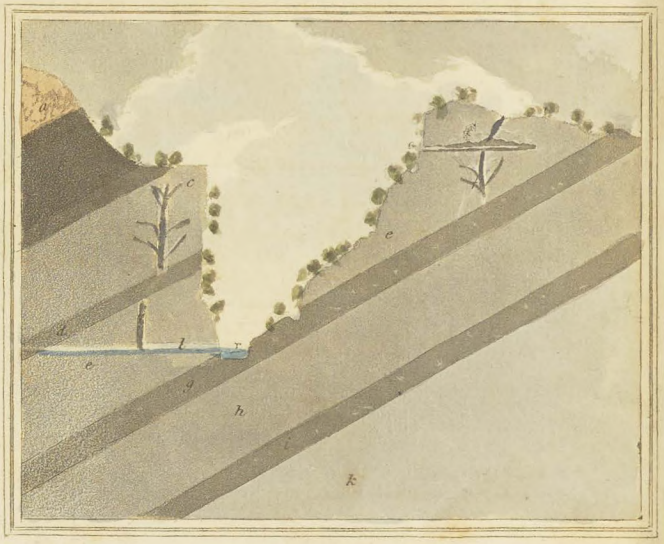


A BRAZILIAN MINER, WASHING THE ALLUVIAL SOIL
(RAKED FROM THE RIVULET) FOR GOLD & DIAMONDS.



SECTION OF THE STRATA, AT MATLOCK HIGH TOR, DERBYSHIRE.

FAMILIAR LESSONS

ON

MINERALOGY AND GEOLOGY;

EXPLAINING

THE EASIEST METHODS OF DISCRIMINATING

MINERALS,

AND

THE EARTHY SUBSTANCES, GENERALLY CALLED

ROCKS,

WHICH COMPOSE THE PRIMITIVE, SECONDARY, FLOETZ OR FLAT, AND ALLUVIAL FORMATIONS:

To which is added,

A Description of the Lapidaries' Apparatus, &c.

WITH

ENGRAVINGS AND COLOURED PLATES.

BY J. MAWE,

Honorary Member of the Mineralogical Society of Jena,
Author of the New Descriptive Catalogue of Minerals, Travels in Brazil, Treatise on Diamonds, &c.

SECOND EDITION.

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PREFACE.

AT a period so distinguished as the present for the intellectual zeal of our countrymen, it is not wonderful that MINERALOGY should have attained its due elevation in the rank of physical sciences: our universities, awakened to the importance of cultivating this branch of knowledge, have diffused through their various channels no small degree of information on this interesting topic. The science indeed owes much of its present success to the labours of the present Professors established at Cambridge and Oxford; and from the unabated enthusiasm of Dr. Clarke, and the Rev. W. Buckland, we may attribute much of its present popularity. Mineralogy, as it is universally useful, will soon be almost universally understood. The possessor of landed estates, and the man of science, the manufacturer and the artisan, may all render Mineralogy subservient to their respec-

tive interests; and the object of these Familiar Lessons is to unlock, as it were, a casket of useful knowledge, and to present to the *learner* a compendious view of the beauty and value of its contents.

The author has carefully avoided obscure terms and technical phraseology, studiously aiming at simplicity in description. His endeavours to become explicit, may have unavoidably betrayed him into a repetition of expression. It is his chief desire that an acquaintance with our mineral resources may be cultivated rather as a recreation than a study; that the produce of our mines may be regarded as an object of interest, and that the traveller may be able to recognise the substances that compose the mountains, the rocks which he may see, and the ground on which he treads.

Mineralogy may be contemplated in two points of view: we may consider it as closely connected with the more common affairs of life, and consequently inviting us to pursue it from its utility; or by affording to us continual examples of mathematical regularity, and of the undeviating order of Nature, it may, like Astronomy, accustom the student to sublime speculations, and thus become the means of enlarging and dignifying the faculties of his understanding.

Rare specimens are by no means necessary to obtain a competent knowledge of Minerals. A careful perusal of a small and select collection, will benefit the student more than many hundreds expended in mere *rarities*, though such are, indeed, beneficial to the *private* or public dealer, who may artfully introduce them to the opulent amateur!

In estimating the value of a science, and in comparing objects of utility with each other, the intelligent reader will not put the grass-hopper or butterfly in competition with the Horse or Ox.

We may have too much *Tantalum* *,
As well as too much *Lead*.

The author, well aware of defects, solicits the assistance of the better informed Mineralogist, and will feel himself greatly obliged by any useful communication on this subject. He is aware of the difficulties which attend any one who endeavours to simplify what is complicated, or to disentangle what is perplexed in any science: confessing his little pretensions to theoretical knowledge, he undertakes the present labour with great

* Tantalum is a new discovered metal.

diffidence, being conscious of the excellent and learned elementary treatises from which he has received instruction and delight. The present little work is intended as a guide to more comprehensive publications, and the author will think himself amply remunerated, if it should become instrumental in promoting the interest of the science.

The excellent books published by Mr. Phillips have tended to extend the study of Mineralogy.

Mr. Parkes's Chemical Catechism will be of great use to the Student.

The fine work on British Mineralogy, by Mr. Sowerby, will make a valuable acquisition to any library.


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Description and Explanation

OF THE

COLOURED PLATE OF MINERALS.

No.

1. Native Copper, in branches, with Crystals of Ruby Copper.
2. Yellow Copper Ore, mammilated.
3. Malachite, zoned.
4. Common Lead Ore, fracture cubic.
5. White, or Carbonate of Lead, accicular.
6. Green Lead Ore, in six-sided prisms.
7. Cubic Iron Pyrites.
8. Brown, or Liver Pyrites.
9. Hæmatites, shewing a diverging or radiated fracture.
10. Black Blende, in aggregate Crystals on Barytes.
11. Calamine, coating a six-sided pyramid of Calc Spar.

No.

12. Violet coloured cubic Fluor.
13. Barytes, tabular.
14. Six-sided Crystal of Calc Spar, with three-sided termination.
15. Common Crystal of Calc Spar, double six-sided pyramid, joined at their base.
16. Rock Crystal or Quartz, with six-sided termination.
17. Garnets.
18. Ribbon Jasper.
19. Chalcedony, stalactitic and mammilated.
20. Iceland glass, Obsidian, shewing a conchoidal fracture.
21. Red Porphyry.
22. Common Red Granite.

THE learner will more readily obtain a knowledge of Minerals by resorting to a little chemical assistance, which will prove of great importance, as the acids properly applied dissolve the metals, and the tests will precipitate them under various forms or colours at pleasure; these pretty experiments may be made in watch glasses, using a few drops of the articles alluded to. He will also be much gratified with the use of the blow-pipe, or by compressing air any way, so as to produce a steady current; but the best is the small one used by blowing through it, and directing the air across the flame of a candle, which produces in a few seconds such a degree of heat, as to melt small particles of Gold, Silver, Copper, &c. when placed in a hollow made in a piece of charcoal, and held in contact with the flame. These experiments are particularly interesting, and so immediately under the eye of the practitioner, that by the fumes, and observing their changes, the most gratifying and important facts are illustrated: the whole of this apparatus scarcely occupies the space of a tea-caddy. Particulars of which, and explanations of the tests, may be had of the Author.

It is needless to state the great use of Chemistry and Mineralogy, as they now form a part of every one's education, and the pursuit of one opens so many pleasing facts, as to be certain to lead to the other, and thus the learner becomes delighted, and almost imperceptibly introduced to the acquaintance of both.

FAMILIAR LESSONS

ON

Mineralogy.

LESSON I.

TO explain what is meant by Fossils or Minerals, and how to distinguish one substance from another, is the subject of the following pages.

Minerals are produced in the earth, and commonly situated in what are termed veins, which, when worked, are called mines, whether at the greatest depth we have penetrated, or in the alluvial soil on the surface. Be it a Diamond, a Coal, or any Metallic substance, it is a Mineral. The Gems are usually called Stones, and crystallizations, fossils; yet all are ranked under the term Minerals. A distinct piece is commonly called a specimen, and a number of various substances, a collection.

It is true, that this science is not marked by those distinguishing laws, that are the leading features of the Sister sciences, yet a general knowledge may be attained with little difficulty, although the way to set about it

may appear clouded and a little obscure; when, however, this mist is once cleared, a brilliant display of Useful knowledge is opened to our senses, and by advancing step by step, the summit will be gained.

To suppose that any one unacquainted with minerals can discriminate them, would be as unreasonable as to expect that an unlettered man should discriminate classical authors without seeing the title-page of their works!

Without further preface, I will endeavour to point out the most easy method by which a learner, who has a few minerals, may have the means of proving to himself what they are, *viz.*

Suppose a person to possess a piece of Lead Ore, Rock Crystal or Quartz, shining yellow Pyrites, or Calcareous Spar, and a few Pebbles that have been found on the sea shore; these substances are selected as being the most common, and which are generally met with; and further, I will for example, suppose him to ask the following question:—

QUESTION. *How can I satisfy myself that this is Lead Ore, or this Rock Crystal, or this Pyrites, and this Calcareous Spar?* *

In reply to this, the first question, observe the colour, and remark its great weight, both of which approach lead; break a small portion, and notice the fragments

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* The learner should provide himself with a little instrument called a blow-pipe, a magnet, a few small bottles with acids and tests, and a small steel mortar; with the assistance of these much may be done by himself, but in the first instance one lesson from a practitioner will be worth a volume of letter-press.

and their metallic lustre—it will be brittle if cut with the knife, or place a bit not larger than a pepper corn on a piece of charcoal, then with the blow-pipe blow through the flame of the candle, directing the jet of flame proceeding from it upon the Lead Ore; it will almost instantly discharge sulphureous vapours, and in less than half a minute melt into Lead. If the experiment is attended with this result, it furnishes a decided answer.

The ores of this metal are both various and numerous; the most common is Blue Lead Ore, which occurs in great quantity, and from it the lead in commerce is chiefly produced.

The ores of Lead, whether blue, white, green, &c. yield to the blow-pipe, and may be reduced in a watch glass, with a few drops of nitrous acid, over the flame of a candle or lamp; the contents being thrown into a glass of water, the lead will be held in solution, and on immerging a piece or rod of Zink, it will precipitate upon it in a metallic state.

The white ores of Lead become orange and red at different degrees of heat; some varieties decrepitate or start from the charcoal on the sudden application of heat, to prevent which, reduce it to powder, and mix it with a little powdered borax, or apply the heat very gradually.

QUESTION. *How can I determine this to be Crystal* Quartz?*

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* The general term *Crystal* signifies Rock Crystal; but we say, a Crystal of Topaz, a Crystal of Lead, a Crystal of Quartz, &c. which denotes the substance to have a geometric form.

Rock Crystal, when pure, is perfectly transparent, but it is subject to specks and flaws; it occurs, generally, presenting six sides terminated by a point; when not crystallized, it has the appearance of a piece of broken glass, but not so heavy; it may always be known by its hardness; it cannot be scratched with the knife; it gives fire with steel; its fracture is almost invariably shining and uneven, often curvelinear: the fragments are very sharp and irregular; heat has no effect on it, but if reduced to powder, and mixed with potass or soda, it melts and forms glass: after once comparing Crystal and Calcareous Spar, and trying their hardness against each other, or with a knife, the learner will easily determine these substances which are so generally mistaken, and which are the most common.

White Topaz resembles Crystal, but it is much heavier, and has a flat foliated fracture in one direction.

Quartz is a variety of Crystal, less transparent, often opaque, and often of different colours.

These easy experiments, performed in a few minutes so satisfactorily, cannot fail to lead the learner forward; they are every thing to the beginner, and may be considered the first and second letters of the alphabet.

The exterior form of fragments, fracture, nice discrimination, tact, &c. belonging to minerals, cannot be known as it were by magic, or attained all at once: books afford but little information to the beginner, and indeed for him, what are considered the best books, may be deemed the worst, as they often disgust by their prolixity, and by their continued use of harsh phrases and technical terms almost impossible for him to understand. Such works, though highly useful to the connoisseur, and to the experimental mineralogist, are un-

intelligible and unfit for the generality of those who are yet unacquainted with minerals.

SPAR.—Sparry Limestone, Calcareous Spar.

What is called Spar is one of the most common objects in mining countries, and generally understood to be a brittle shining substance, that will burn to Lime, but Spar is not a very definite term, as Crystal Quartz is called Spar in Cornwall. We have also Adamantine Spar, Fluor Spar, Felspar, &c.

To know if the substance is Calcareous Spar, (carbonate of lime), proceed as follows:—Apply the point of a knife, and if it is brittle and easily scratched, leaving a white powder, it may be presumed to be Calcareous Spar, or by placing a fragment on a hot fire shovel, it will become opaque, and burn to Lime, which may be known by its styptic taste, or by throwing it into a glass of water, when it will fall to powder with a hissing noise. Calcareous Spar exhibits a smooth and shining surface (glass-like), when broken, its fragments will be of a rhombic form; it effervesces with acids, even with strong vinegar; if reduced to powder, and when transparent, as the Icelandic variety, it has the property, in a high degree, of reflecting objects double, arising from its great power of refraction. This effect may be best seen by placing a pin underneath it, when two will appear more or less distant from each other, as the piece of Spar is thick or thin. This singular and pleasing effect has not yet been fully accounted for.

Let it now be supposed the learner has received some shining yellow *Pyrites* *, which being very heavy, he believes to be Gold, or to contain Gold.

QUESTION. *How am I to proceed to know yellow Pyrites from Gold?*

In answer to this question let the learner attempt to cut the specimen with the point of a knife; if it is Gold, it will be soft, and may be cut like lead, or if he strike it gently with the small end of a hammer, it will be indented, Gold being malleable; if he melt a small particle with the blow-pipe, its colour will remain the same; but if it be brittle and hard to the knife and hammer, it is a proof that it is not Gold; or if he place a few fragments upon a hot fire shovel, or under the flame of the blow-pipe, and the sulphur burn away, leaving scoria that is attracted by the magnet, this proves it to be a combination of Sulphur and Iron, which is answering this interesting question with great facility: or if he put a few of the particles into a watch-glass, and drop a little nitrous acid upon it, and hold it over the flame of a lamp or candle until it boils, if it is Gold, no alteration will take place; but if not, an effervescence and change of colour will be the result, which shews that the substance is acted upon by the acid; the contents may be thrown into a glass of water, into which if he let fall a few

* How many, having met with this common substance, both abroad and at home, have treasured it with the greatest secrecy, believing they had discovered a Gold mine. Brazil, Rio de la Plata, Africa, &c. can testify the mistakes many people have made by not being able to discriminate one from the other.

drops of prussiate of potass, the liquid will become a beautiful blue. The Iron of the Pyrites being dissolved by the acid, and held in solution in the water, is as it were regenerated, and precipitated in the form of Prussian Blue, after which the water becomes again clear. This elegant and easy proof cannot fail to give pleasure to the learner, and shews that the steps to the attainment of some knowledge of Minerals are by no means difficult, and will not fail to prepare and encourage his mind for other experiments.

Gold is generally obtained from the alluvial soil, in small scaly particles, called grains or Gold dust, seldom so large as a pea. What are called the Gold mines of Brazil and Africa are on the surface: the simple act of washing peculiar places separates the Gold from the gravel, and by this means great quantities are found. In Brazil alone, above twenty tons weight are annually procured, which forms a large share of the circulating medium of Europe. The mining district is called Minas Gerais; the reader will learn with surprise that it does not contain one deep mine or one subterraneous excavation. What is there termed a mine, is a peculiar place or superficies of greater or less extent, where the surface is raked from or dug to the solid rock, consisting of rounded substances, earthy matter, sometimes Precious Stones, as Topaz, Aqua-marinas, &c. besides Gold and Diamonds, of which it is the great receptacle.

This argues, that these granular particles of Gold have been disseminated in the mountains, and which, from the decomposition of their exterior, have been washed down by heavy rain to their present situation. It is com-

mon to see Pyrites so *dispersed*, and I have some specimens where the gold is so distributed, but they are very rare.

Some particles of Gold are so extremely delicate, as to float on water, and cannot be separated from the accompanying matter, without mercury, (which, on being rubbed strongly amongst it, takes up the gold) and amalgamates with it.

In Africa Gold Dust is an article of commerce, and considerable quantities are exposed for sale. It is often adulterated with such Pyrites which is the nearest to it in colour, and not unfrequently with Brass filings, which the merchants appear not to know how to detect, and from the want of this sort of knowledge, many have suffered great loss; some of the better informed negroes make a trade of "trying Gold," and are called "Tryers." Merchants and captains pay them particular attention and respect when they are employed on this business, as from their slight knowledge they save their employers from imposition; on these days the poor negro is admitted to the captain's table.

Gold Dust, if adulterated with brass filings, may be detected with nitrous acid, as before described; the solution will be green, and on being put into a glass of water, to which add a few drops of ammonia, it will become blue.

Platina is found also in grains, the same way as Gold; it is of a white colour, more like Silver, hence called Platina, being the diminutive of *Plata*, meaning silver in the Spanish language.

Pyrites. There are many varieties; some contain a large portion of arsenic, and are then called Arsenical Pyrites, the colour of which is from pale yellow to almost tin white, and may be known also when exposed to heat by the fumes and peculiar smell, like garlic. Pyrites is hard and brittle, often crystallized in the forms of cubes and octohedrons.

Rounded stones from the gravel, or gathered from the sea coast, &c. may, with little examination and attention, be generally known and determined.

ON DIAMONDS.

How many gather Pebbles, small rounded Crystal, believing them to be Diamonds; indeed, so little are Diamonds known, that it is difficult to convince some pebble collectors that they are not so, even after they have been cut and polished!

As it is well known that Diamonds cut glass, many imagine that a Crystal, Pebble, gathered from these sources, hard enough to *scratch* glass, and shine when polished, must either be a Diamond, or something nearly related to it! This is not to be wondered at, when it is considered how few have seen rough Diamonds, or have ever given it a thought, that there is a difference between scratching glass and cutting it.

The Diamond acts so extraordinarily upon it, that however thick the plate (of glass), it separates frequently in the very act of drawing the Diamond over, as if cut

asunder, whereas other substances merely scratch it, and do not produce any other effect; Crystal Pebbles, compared with Diamonds, are not so heavy by about one-third. Large Diamonds are extremely rare, therefore those generally offered for sale, in the rough state, are very small, seldom so large as a horse bean, but more commonly about the size of a pepper-corn; they have almost always a sort of shining metallic hue and a crystalline form, exhibiting planes and angles different from those of any stone. The beginner, without confining himself to these marks of discrimination, may procure a fine file, and rub the substance with a little pressure; if it be a pebble, the file will with difficulty leave an impression; if it be small, place it betwixt two penny pieces, and strongly press them with the thumb and finger, it will be reduced to powder if it be not a Diamond, or he may try it on a lapidaries' wheel, which will wear down the Crystal, but will not produce any effect on the Diamond.

Diamonds may easily be known from stones which are cut and polished, so as to resemble them. The light will pass through the Crystal, paste, &c.; whereas in the Diamond, the rays are, by its great refractive powers, reflected to the surface, which gives it the highly marked rank it holds in society, viz. Diamonds are always known by the beholder, who, however distant, distinguishes the dazzling proud reflected ray of light, which is not the case with stones or paste; they are best seen by those who are nearest to them.

Rough Crystal, Pebbles, often appear rounded and opaque, also as if polished, presenting, *when perfect*, eighteen planes: many have brought them from Suri-

nam, Maravina, &c. for Diamonds; the best method of obtaining a real knowledge of their difference, is by comparing them together.

After due attention to these remarks, transparent substances will not be mistaken for Diamonds.

Substances usually met with on the Sea Coast.

GRAVEL, &c.

The substances from these sources are commonly hard and siliceous, as Quartz and Crystal, already noticed; they are rounded, and often of a brown colour.

Flint is too generally known to need description.

Chalcedony, Agates, Jaspers, the varieties of which are numerous in these situations. They all give fire when struck against steel, do not yield to the knife, and when broken, have generally a shining, curved, or uneven fracture; the fragments are splintery and sharp edged.

Chalcedony often occurs rounded amongst the Pebbles of the sea shore; it is of very close texture; fracture, not shining; colour generally pale milk blue; is often marked by straight white lines, parallel to each other, and frequently resembles white carnelian.

Agate. Is a substance so generally known, as to need but little description: many are particularly beautiful when cut and polished. Agate commonly consists

of Chalcedony, Quartz, and Jasper, the angular and concentric lines, the Crystals of Quartz frequently lining cavities, serve to shew that their exterior was formed first, and that they have been filled by a siliceous deposit in solution at distant periods, and owe their colour to Iron. The exterior of Agate is rough and spheroidal, often indented, and of a dirty green colour.

Jaspers, in point of variety, do not fall short of the preceding family; some are much interlinked with Agate, although their formation is different. Jaspers are of great variety of colour, as brown, red, yellow, green, &c. they often form a part of Agate in red stripes and angular lines, blotches, spots, moss-like and dendritic appearances; also curious resemblances of Lusus Natura, some of which are highly valued.

Jasper is of a fine texture, exterior appearance smooth, and often strongly coloured, red, yellow, &c.; it is very tough and difficult to break, contains a large portion of Iron, particularly the red variety.

Many collectors have a small lapidaries' apparatus for cutting and polishing Pebbles, which will perform all the operations; also is extremely useful for polishing shells, &c. and so portable as to be set on a parlour table.

Rounded pieces of *Granite*, *Green Stone*, and *Porphyry*, occur less frequently in this situation, though they are not uncommon, therefore it may not be improper to notice them in this place.

Granite is composed of three distinct substances, viz. Mica, Quartz, and Feldspar, which the learner will

easily discriminate, after once having had the substances pointed out and explained. (See Granite.)

Green Stone is composed of Hornblend and Feldspar: it is generally hard, and of a dull green colour, often spotted.

Porphyry is a substance that equals Jasper in hardness, and is generally of a brown or red brown colour, speckled with whitish spots; these spots are very seldom round, almost always angular. Porphyry is often met with in a decomposing state, it then is much softer, and finally becomes Clay.

Limestone, *Slate*, *Sandstone*, and semi-indurated *Argillacious* substances, rarely occur in *Gravel*, or amongst the Pebbles of a surf-beaten sea-coast; because they are not sufficiently hard to resist the action of attrition, and are soon broken down, forming sand, dust.

A little thought on these substances, after looking at them with attention, will convince the learner that he is making some progress, and he will feel pleased at being enabled to proceed with greater facility.

LESSON II.

COPPER.

The learner may now be led to inquire—

How he can discriminate Ores of Copper ?

Ores of Copper are found in abundance and in great variety, but as it is not my intention in this little work to endeavour to explain all their appearances, I shall merely describe the substance generally.

Ores of Copper have commonly a yellow appearance, the poorer Ores much resembling Pyrites, and contain a large portion of Sulphur and Iron, but are softer to the touch of the knife. Copper Ores, that are richer, are of a Gold yellow; some are irridescent, exhibiting a pretty and variable display of colour, and are called Peacock Copper. These varieties have a deeper and more flame-like tinge than common Pyrites.

Copper Ores are also frequently green, and in delicate fibres ; sometimes compact, beautifully zoned, of lighter and darker shades, exhibiting great variety : these are called Malachite, which is not unfrequently mixed with blue, of various shades.

Copper Ores are often metallic grey, not unlike Iron, also Ruby-red, brick-red, black, even soot-like; but for fear of tiring the learner with prolixity, I will

explain the easiest method of detecting them, previously observing, that Copper is not uncommon in its native state, when it appears as if compressed in leaves, foliated, massive, branch-like, &c. pieces of this description are often found in veins, particularly in Cornwall: this sort of Copper so much resembles the general Copper of commerce, in colour and texture, that it needs no other description.

The learner will easily detect Native Copper by it being little harder than lead, also bright and flexible. The ores, whether grey or yellow, will be more or less hard to the knife as they are poor or rich, the best being the softest: or let him place a small particle of it upon a piece of charcoal, with a little borax, directing the flame from the blow-pipe upon it, the ore will soon melt, and if it be rich in metal, it will be reduced to a bead of pure Copper, colouring the slag green, or red brown; it is sometimes necessary to repeat the operation. Ores of Copper, if combined with arsenical acid, may be known by their being easily fused, and giving copious vapours which smell of garlic.

Phosphates of Copper may be known by their melting as soon as the flame is applied, producing a brown slag. Muriate of Copper tinges the flame a beautiful blue, and afterwards an emerald green colour.

A more easy method of detecting Copper is as follows:

Reduce a small particle to powder; put it into a watch glass, with a few drops of diluted nitric acid; if no action takes place, apply a little heat, by holding it over the flame of a lamp; the Copper will soon be acted upon and dissolved by the acid, then add a few drops of

water, and stir it with the point of a knife, or any piece of clean iron, when the Copper will precipitate upon it; or the contents of the watch-glass may be thrown into a glass of water; to which add a few drops of liquid ammonia, and it will become a beautiful blue.

This pretty experiment, so convincing in effect, will add considerably to the learner's confidence *.

Even water passing through a vein of this metal, often contains a large portion of it in solution. These waters are collected in reservoirs with great care, into which Iron of any description is thrown, and in a few days it becomes coated with a strong covering of Copper, which is scraped off, and the Iron again plunged into the water; this is repeated so long as any Copper remains in it, and frequently by this method several tons are obtained. The metal thus produced is very pure, and used for the finest purposes.

The before-named substances are amongst those which most generally occur in this country; it is not my intention, nor would it suit the learner in this early stage, to enter into more varieties or their peculiarities, or more minute detail; that may take place hereafter.

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* A similar effect will be produced by using an Ore of Nickel; should any doubt exist, let sulphuric or nitric acid be added to the solution, slightly in excess, when the immersion of a bar of Zinc will precipitate any Copper which may be present, but no effect will be produced on Nickel; should a dirty mud coloured precipitate take place, it may be found to arise from a mixture of Arsenic and Iron, with which common specimens of Nickel abound.

SILVER.

As *Silver* has been met with in various parts of Cornwall and Devonshire, the learner will naturally enquire—

How he can know substances containing Silver?

Native or *Virgin Silver*, as it is sometimes called, occurs in delicate curled fibres, of a silk white colour, and filling little cavities in Quartz, nests; these fibres are tough and flexible, often surrounded by a black, earthy, soot-like substance. Silver is frequently branch-like in strong ramifications, or leaf-like; also passing through Spar and other substances, in long serrated wire-like branches, detached or connected, and frequently interwoven, crossing each other net-like. These Silvers have often a fine rich metallic lustre, of a tin-white colour, though sometimes tarnished.

Silver in this state, *Native Silver*, cannot be mistaken after having been once examined, but it may be proved by the touch of the knife, as it yields to it, being little harder than lead; it is malleable, and indented by the smallest blow of the hammer, and melts into a beautiful white globule.

It greatly resembles Tin in colour, but may be easily known from that metal, being much heavier, and by the cracking noise which Tin makes when bending, or by the latter burning away under a continued heat, whereas Silver remains unaltered.

By due attention to these remarks, Silver may be discovered, and as the Ores of Silver are frequently combined with other metals, the following easy experiment will detect it.

If it be a rich ore it will be soft to the knife or hammer, and melt under the blow-pipe with little difficulty, and by repeated fusing with borax, a bead of Silver may be produced; the combinations will be driven off by heat, or absorbed by the borax.

Or a few small particles of the Ore may be put into a watch-glass, into which drop a little nitric acid, then hold it over the flame until it is dissolved, after which dilute it with water, and stir it about with a bright Copper wire; if any Silver is present, it will precipitate upon the Copper, covering it with Silver, (not exactly as Iron is before described to be covered with Copper;) or add to the solution one drop of muriatic acid or a little common salt, and the Silver will precipitate in a thick and dull white cloud *.

If the ore contains a large portion of Copper, which is frequently the case, it will shew itself in melting, by colouring the borax green, also by superficially coating the Silver, and finally burn away with a green flame, if the heat be continued.

If the ore contains Lead, it will be more easily driven

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* Lead also is precipitated by the muriatic salts, but the two metals may be easily distinguished: the precipitate occasioned by the presence of Silver quickly turns black by exposure to light, and is perfectly insoluble in water. That resulting from Lead is not affected by light, is soluble in about 25 times its bulk of boiling water, and also in nitric acid.

off by heat, colouring the charcoal a whitish yellow; other combinations, as Sulphur, Arsenic, Antimony, and Bismuth, are easily evaporated.

Ores of Silver are very commonly combined with the above-named metals, which may be known by the fumes. Antimony burns with a thick white smoke. Sulphur and Arsenic may be detected by the smell.

These experiments will open the mind to further investigation. They may be performed with ease and elegance, by merely possessing the few tests before mentioned.

IRON.

Ores of Iron. *Iron* presents itself in abundance, and exhibits a great variety of appearances.

Clay, Sandstone, and Jaspers, frequently contain a considerable proportion of Iron, which gives to them their red colour. In some stages it is more subject to decomposition than in others, and the more Iron they contain, the more tinged the substance becomes, the colour being generally brown or yellow. Many indurated clay-like stones appear ochreous, and on breaking them, the three stages of decomposition are often instructively and beautifully marked, elucidating their change; whereas the centre remains perfect, unaltered, hard, not having yet been affected by either water or air, the action of which has given the surface so different an appearance.

Other Ores of Iron, as those called *Hematites*, are

red, often black, red, and brown, with a fibrous texture; kidney shaped, and have a metallic appearance; they are heavy, and frequently appear as if polished; they are also sometimes encrusted with red dusty matter, which soils the fingers.

There are yet others, granular and compact, as *Loadstone* and shining *Specular Iron Ores;* some have the appearance of aggregated particles of Iron or Steel. The beautiful Ore from Elba presents itself in large crystallized groups, of the most beautiful colours, and of the greatest splendor; but this series, so interesting to the uses of man, is leading me beyond the bounds I had prescribed myself.

Ores of Iron may generally be detected by placing a small particle under the flame of the blow-pipe to drive off the sulphur, &c; it will not melt, but after it has been kept red-hot a few moments, the magnet will exert its unerring power, and attract it; (many varieties are magnetic without heat;) or, reduce the particles to powder, put it into a watch-glass, to which add a drop or two of sulphuric acid, and expose it to the flame of a lamp, throw the contents into a glass of water, into which pour a little tincture of galls, and you will have Ink; or the beautiful blue, if prussiate of potash be used instead of the tincture of galls.

The most general Iron Ore of England, is *Clay Iron Stone*, which may be considered a deposit. It is almost always found near Coal, which is so necessary for melting it, in order to produce Iron. So common as this useful metal is, yet how few know any thing of the process it undergoes before it becomes malleable; and applicable to our wants. It is one of the most difficult Ores

to reduce, and more art and labour is requisite to conduct a small Iron furnace, than to melt all the Gold produced in Brazil.

MANGANESE.

Here is a substance of a dark colour and earthy appearance, that you have told me is *Manganese.*

How or in what manner can I detect it, or assure myself that it is so?

Let it be first understood that the ores of Manganese cannot be reduced to metal by the blow pipe, and in order to detect them, observe as follows, viz.:

Manganese in its general appearance is earthy, brown, and black, soils the fingers when touched, and frequently contains delicate fibres of a bright iron-like lustre. Another variety is striated and accicular, of a metallic appearance and heavy, is soft to the knife, and after regarding it, may easily be distinguished from any other mineral. It also occurs with earthy substances, tinging them a beautiful rose or pink colour.

Put a small portion, reduced to powder, in a glass, to which add a little muriatic acid, and hold it over the flame of a lamp. If Manganese be present, it will occasion a disengagement of gas (Chlorine), which may be known by its suffocating odour, and by its discharging the colour from printed linen previously moistened, if exposed to the fumes.

With the blow pipe Manganese presents some curious and pleasing phenomena. A very small particle, after being exposed to a red heat, placed on charcoal, with ten times its bulk of borax, and fused by the interior flame, forms a globule of a violet colour, suffer it to cool, and gently re-melt it, and the colour will be found to have vanished. It may be reproduced by again melting it with the exterior yellow flame, or by adding a bit of nitre, which will be best seen by drawing it whilst melted into fibres with a pair of forceps.

Manganese is supposed to give the colour to Amethysts, and other beautiful gems. Calcarious Spar and Quartz derive their pink tinge from it. The dendritical appearances on various substances, and the beautiful moss-like representations in Mocha stones, owe their origin to it. Manganese is common in Devonshire, and worth about 7*l.* per ton. It is of the first importance in making glass, and has been called the mineral Camelion!

I cannot sufficiently recommend an acquaintance with the preceding substances, and the different methods of discrimination; for if the learner has once familiarized himself with the characters of them, and with the means of detecting what they are, he will then have gained the first steps to the knowledge of mineralogy as a science, from which too many have started back, and could not prevail upon themselves to proceed.

Ascertaining metallic substances by these easy experiments, will give the learner some idea of the invaluable use of chemistry, with which almost every thing useful to man is connected, and cannot be too earnestly cultivated.

LESSON III.

ON THE GENERAL APPEARANCE OF THE ORES OF TIN.

The general use of *Tin* naturally presents itself to the notice of the teacher; it is not so much distributed as many other Minerals, but its ores exist in abundance where it has hitherto been found. It is one of the heaviest minerals and one of the lightest metals. It consists of few varieties; which may generally be known by their great weight; it is sometimes of a resinous colour, but commonly approaching black, and its crystals occur in groups, presenting planes, intersecting each other, which mostly have a lustre as if polished. It is hard, and with difficulty scratched by the knife. It occurs in veins, some of which are so delicate, as not to be thicker than the blade of a knife. It also is met with in small heavy pieces, having a diverging striæ, and a ligneous appearance; hence called Wood Tin.

The Ores of this metal are not easily reduced; but after being exposed to a red heat, they should be pulverized, and mixed with soda and charcoal, then exposed to the blow pipe, on a clay support; minute globules of Tin will appear. Care must be taken not to continue the heat, or it will burn, and become a white powder. The same Ore, melted with glass, will produce an opaque enamel.

Ores of Tin* cannot be described, so as to give a perfect idea of them; they resemble Ores of Iron in some cases, also Ores of Blende, but are harder, much heavier, and will not be mistaken, after observing the preceding description; on comparison, the learner will be enabled to distinguish Tin from those ores which resemble it.

Ores of Tin have hitherto only been discovered in the Granitic Rocks and Clay Slate; they have not been found in any part of this kingdom but in Cornwall and Devonshire!

ZINC.

I am extremely delighted at being enabled to discriminate one substance from another. Pray inform me,

How I can know the Ores of Zinc?

Ores of Zinc form two distinct substances, as *Blende* or *Black Jack* and *Calamine*, both of which present several varieties, though they form the same metal.

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* Tin may be detected by digesting a portion of the Ore in muriatic acid, and adding a few drops of muriate of gold, which will produce a purple precipitate: it is essential that both the solutions should be fresh prepared. The muriate of gold may be readily formed, by putting a little gold-leaf into a glass tube, with a small quantity of muriatic acid, and adding nitric acid, by a few drops at a time, until the solution is effected; it will be facilitated, by exposing the tube to a moderate heat.

Blende is commonly black, brown, or yellow, of different shades; is massive, and often appearing in clusters (confusedly crystallized) upon the surface of specimens, and may be known by the touch of the knife, being soft, and by scratching it, a lighter coloured powder is produced; some of the yellow variety, when rubbed, even with a pen, yields phosphorescent sparks. These Ores are neither so heavy or so hard as Tin, and by comparison they may be readily distinguished. Under the strong flame of the blow-pipe Blende often evaporates and goes off in white flakes.

Common Calamine, both in its crystallized or amorphous state, bears considerable resemblance to some of the earthy minerals; its superior weight will, however, lead to a suspicion of its metallic nature. From Argillaceous Stones it will be distinguished, by the want of their peculiar odour when breathed on, and by not becoming tenacious when moistened; it also effervesces strongly in acids. From the Carbonates of Barytes and Lime it may be known, by placing on the back of the hand a particle which has been recently exposed to the blow-pipe; on moistening it, the heat which is evolved under these circumstances by the above-named earths, will not be experienced. Before the blow-pipe it is infusible, but loses about one-third of its weight; and if the heat is continued, it escapes in white particles. In nitric acid, moderately diluted and warmed, it dissolves with considerable rapidity and effervescence; pour a small quantity of the solution into a glass tube, and on adding ammonia, a white precipitate will ensue, which will re-dissolve on adding an excess of ammonia. A

slip of paper immersed in the solution, and then held within a few inches of glowing coals, will kindle spontaneously soon after its becoming dry. On slowly evaporating the solution, the crystals which form will detonate when projected on ignited charcoal: these characters sufficiently distinguish it from other minerals.

Calamine occurs brown, yellow, and green, and has commonly an earthy appearance of a brownish colour; it is generally porous, but sometimes compact, and this species, when struck, yields a metallic sound. Some varieties become electric on being warmed, and give sparks with steel. It is in great abundance in Derbyshire, and is used to convert copper into brass. Ores of Zinc are a late discovery, that metal being imported from China formerly.

The presence of Zinc in any ore may also be known by mixing a small portion of it with a few grains of Copper filings, and a little charcoal; on cautiously applying the flame of the blow-pipe, so as not to volatilize the Zinc, the Copper will be found converted into Brass. Should an Ore of Blende be used in this experiment it will be necessary to subject it previously to a moderate heat, to drive off the sulphur.

A very pretty experiment is performed with a small particle of Zinc, which though so generally known, I will detail, for the purpose of shewing the great affinity it has for lead.

Example. Lead is acted upon by vinegar, and forms acetate or sugar of lead, which, when dissolved in water, is a transparent liquid solution, leaving a white precipitate. If a piece of Zinc be suspended by a thread,

and immerged in the fluid, it will be covered almost instantly by the finest flakes of lead, regenerated in its metallic state, which may be seen approaching it in all directions.

This beautiful, amusing, and instructive experiment, cannot sufficiently be admired; it is a lesson upon attraction and affinity, which cannot fail to please those who have not heretofore seen it performed.

I have felt it my duty to be thus explicit in stating how the ores of the three last metals (so useful in our occupations) might be known chemically, in order that the learner may not be checked in his progress. though he will more readily distinguish what they are by examining and comparing them with others.

MERCURY.

When Mercury, commonly called Quicksilver, occurs in the state of Ore, how can it be known in its rough and natural appearance?

Quicksilver once seen, cannot be mistaken; it exists in semi-indurated Clay, in Sandstone, and other earthy productions; it often occurs in small and large fluid globules, commonly attended with a red substance; large quantities are obtained in the fluid state. The Ores, from which the greatest quantity of Mercury is obtained, are called Cinnabar, which, when rich, are extremely heavy, compared with Iron. They are of a red and

brown red colour; some varieties are dull, others bright and shining; they may always be known, if rich, by their great weight, or from the knife leaving a full red streak upon them, or by exposing a particle to the flame of the blow-pipe, white fumes will arise, and a piece of Gold, as a guinea, or a piece of bright Copper, as a half-penny, held over the vapour, will be coated with Mercury, which condenses upon it; and the more it is rubbed the more it will have the appearance of Silver, which cannot easily be removed, but by burning it off. Quicksilver, as a metal, is always fluid in our atmosphere; it may be rendered solid by producing artificial cold.

COBALT.

Perhaps the learner is not acquainted, that the metal called *Cobalt* forms the beautiful blue colour on China, also earthenware, and may be desirous to know how to distinguish Ores of that metal, as it has not been found in a native state.

The Ores of Cobalt are not confined to one peculiar sort: they, like many of the preceding, consist of several varieties, some of which are rich, and yield a great quantity of colouring matter which is highly valuable; others are too poor to pay the expence of being worked. The Ores are generally combined or accompanied with arsenic. They have a whitish grey colour, and metal-like lustre, sometimes tarnished, and approaching to black; they are heavy and hard to the knife.

On examination, some of these ores have more or less intermixture of peach-red efflorescence; others are

dark, earthy, sometimes of various colours, from intermixture of other metals, as black, blue, and green; the latter varieties often occur in Sandstone. The best Cobalt is produced from the Swedish ores.

A very small particle, placed under the flame of the blow-pipe, generally emits fumes of arsenic, after which, if a little borax be melted with it, a deep-coloured blue glass will be produced; Cobalt, melted with Silex, is called smalts. The Ores of this metal occur in Mica Slate, and frequently in detached splendent crystals, of a white metallic lustre; generally cubic or in octohedrons, variously modified. Many amusing experiments may be made with Cobalt, which Parkes's excellent Chemical Catechism explains.

Ores of this metal have lately been found in Cornwall and in the alluvial soil in Cheshire.

ANTIMONY.

Antimony is much used in making Printer's types, in Medicine, &c.

It does not form so many varieties as several of the preceding. It is generally of a lead colour, and frequently occurs in long thin Crystals, like needles, diverging from a centre, and of beautiful irridescent colours. It is also shining bright; this variety resembles Lead; but it more commonly occurs of a dull metallic grey, compact, or composed of accicular fibres. The massive variety is sometimes covered with a yellowish Ochre, from the decomposition of the metal, which is not the case with Ores of Lead. Antimony, after being attentively examined, will not be mistaken

for any other substance. The flame of the blow-pipe will immediately detect it, as it melts the instant it is exposed to heat, and then appears as a dark coloured slag or scoria, swelling and burning away in white fumes.

BISMUTH. NICKEL.

Perhaps the learner has never heard of the metals called *Bismuth* and *Nickel;* they are not common, and their use is rather confined.

Bismuth is a metal that is not malleable, though it is found in a native state, as Gold and Native Copper; but it does not resemble either.

Bismuth has a peculiar agreeable metallic appearance of various colours, resembling most the hue of a Pigeon's Neck, changeable as the light strikes it; which peculiarity may serve to distinguish it from granular Lead Ore. It is soft, and melts the moment it receives the flame, into a white globule, which, if the heat be continued, volatilizes, leaving a white deposit upon the Charcoal.

Bismuth frequently accompanies Ores of Silver, Cobalt, and Nickel, and as its varieties are very few, the learner will be enabled to determine them, after having discerned their peculiarities, by comparing them with other metallic substances.

Nickel is a metal less known than the preceding, and it is not likely the learner, who has never seen it, should know it before he has heard its name; however, if he

has noticed the preceding characters of metals, he will know, on seeing it, that it is not any one of them.

Nickel is massive and compact, lighter coloured than Copper, though approaching to it. It is hard, difficultly scratched by the knife, and is very heavy; any further description could avail little or nothing, but when seen, it would be perceived not to agree with any other substance. It produces a fine apple-green colour in nitric acid. It melts rather difficultly, emitting arsenical fumes that smell like garlic. The above characters are quite sufficient to distinguish it from the metals that it is often associated with. Copper, alloyed with Nickel, forms a metal resembling Gold.

URANITE.

Uranium, *Uranite*, is more easily known than the preceding.

Uranite cannot be mistaken for another substance, if its characters are carefully examined. It is of a beautiful grass-green colour, rarely yellow-green, and generally appears in tender delicate leaf-like quadrangular crystals, many uniting together, forms a surface often half an inch or an inch across. It sometimes occurs in an ochrous state, both green and yellow; another variety, called *Pitch Ore*, which is black, and often accompanied with the ochre, is extremely heavy, and of rare occurrence. Uranite forms very beautiful specimens, and are of considerable value.

WOLFRAM.

Wolfram is a common Mineral in Cornwall, though hitherto of very limited use. It is of a dark colour, approaching to black, brittle, fracture foliated, and hard. It yields a red brown streak to the knife, and is extremely heavy. It differs from Ores of Tin and Iron in these particulars, and is one of those Minerals of which words cannot convey a perfect idea to the learner. It is rarely met with, except in the countries which produce Tin; it is a Tungstate of Iron, consisting of Tungstic acid, Manganese, and Iron.

The following Tungstate of Lime is nearly allied to the preceding.

Tungstein (Tungstate of Lime) is a heavy opaque white coloured Mineral, sometimes yellow brown; it often occurs in fragments, is very compact, and may be known by its great weight; it differs from massive Carbonate of Lead, being harder, and by not dissolving in nitric acid.

These Minerals are not of common occurrence, and for more particulars the reader had better refer to the New Descriptive Catalogue, or an Elementary Work.

The same remark applies to the following; viz.

TITANIUM.

Titanium, which is a Mineral more generally diffused than the preceding, and appears under a variety of forms, some of which may be known by their beautiful capillary appearance in rock crystal. It is generally of a brown or red brown colour, sometimes lighter, and as delicate as hair—hence it is sometimes called Venus's Hair; it also presents itself in regular forms, as thick as a quill. Another variety is found imbedded and wedge-like. Titanium forms beautiful appearances in Quartz, and should be seen to have a just idea of it.

Menachinite belongs to Titanium; it is found in grains of a black colour, intermixed with sand. There are some other granular varieties in larger or smaller grains, which are generally magnetic.

Gold ore is frequently asked for, and many yellow substances are believed to be ores of Gold; but here is a mineral that contains that precious Metal, without the smallest appearance of it; it is called

TELLURIUM.

Tellurium is a whitish coloured shining Mineral, disseminated superficially, in small and delicate leaves and

fibres, of a polished steel colour, often appearing map-like, and from it is named Graphic Ore.

It is sometimes yellowish, and there is a variety that approaches to black; the latter is rich in Gold, and occurs in larger foliæ; they both yield to the knife, and a bead of Gold may be obtained from the richest variety, by melting it with borax. The Graphic variety cannot be mistaken, and the others may easily be discriminated. Tellurium is of rare occurrence, and the learner will seldom meet with it.

MOLYBDENA.

Molybdena is a Mineral not very abundant, though it occurs in many situations; it is generally in small patches, foliated, of a lead colour; it greatly resembles Tellurium, but its leaves are more flexible, and it crystallizes in six-sided tabular plates; it does not melt under the flame of the blow-pipe: it is commonly imbedded in Quartz, and has hitherto only been found in Granitic rocks; it much resembles plumbago, common black lead, but marks porcelain or earthenware with a greenish streak; it is considered to be one of the oldest metals, and always occurs in the primitive rocks.

The following three varieties belong to Tantalite, and may be said to be of late discovery.

Tantalum. Tantalite generally appears imbedded in Granite; it is of a black colour, sometimes streaked,

and greatly resembles Wolfram and Ores of Iron, but it is not magnetic.

Yttrotantalite often occurs imbedded in angular fragments, but more generally forming concretions of a black colour; it is nearly allied to the preceding, and to the following.

Gadolinite is of a pitch brown colour, often surrounded with a red brown coloured substance, and imbedded in Quartz.

These substances are extremely rare, and their uses hitherto so very limited, that I did not, at the commencement of this work, mean to have given them a place in it, nor the following:

Cerium, which is also of late discovery.

Cerite is of a red brown colour, dull appearance, and moderately heavy; it melts partially under the blowpipe, and forms a dark scoria, which is attracted by the magnet.

CHROMIUM.

Chromic acid occurs combined with Lead and Iron; hence Chromate of Lead and Chromate of Iron.

CADMIUM.

A new metal, lately discovered in Ores of Zinc from the Hartz, of which but little is at present known.

WODANUM

Is also a new discovery, with which we are but little acquainted.

SILENUM

Is a late discovery, and said to be obtained from the Sulphur of the Pyrites, from Fahlun in Sweden.

These metals have not hereto been applied to any useful purpose, and, in fact, we know very little about them.

It is the Author's desire that the learner should speedily be enabled to discriminate minerals of common occurrence, which a little practice will enable him to do, without the assistance of chemical aid, or entering the labyrinth of elementary works; but should any doubt arise in his opinion, a knowledge of the means of ascertaining them will greatly add to his confidence, and he will soon perceive the unnecessary complexity of terms and minutiæ which has prevented thousands from attempting to cultivate an acquaintance with the most useful part of this science.

OBSERVATIONS RESPECTING THE METALS.

After having enumerated the metals in the preceding Lessons, and endeavoured to explain in a concise manner how they may be known, a question very naturally arises, viz.:

How are they formed?

Fissures (called veins) must have existed prior to their becoming filled with minerals, but in what manner they have been deposited in these receptacles, is yet considered doubtful: there are many objections to the theories hereto advanced. However, it may not be improper to state the following observations relative to some minerals which appear to be formed by aqueous deposit, and others that exhibit characters of being produced by sublimation.

That the ores of some metals are continually forming, there can be no doubt, as Calamine and Manganese; the former is often found cementing fragments, and coating recently fractured Calcareous Spar, and the latter may be observed deposited in newly made water courses. Lead Ores, both Carbonates and Sulphurets, have been discovered, forming Stalactites. It may be said, that these waters had dissolved the substances they held in

solution, and precipitated them where the impulse of attraction became stronger—it may be so. It is well known, that several metallic ores, with their associates, line the roofs and sides of cavities, which are evidently deposits caused by infiltration. Attraction may have acted a much greater part than has hereto been considered; and if these bodies have originally been in solution, it was possibly the principal agent in bringing their particles together; and hence a deposit would take place from gravity.

That the ores of some metals have existed in gaseous forms, seems equally possible, from the great quantities found in a state of sublimation. The vast operations of nature in her hidden laboratory are much beyond our limited comprehension; but by stating these circumstances within our own observation, it may be preparing the way for more attentive researches.

The Rocks in which these metallic repositories are situated, whether of Granite, the primitive order, or the more late mountain Limestone, do not, on analysis, contain a particle of the metal which they enclose! Metals are frequently imbedded in Rock Crystal, Calcareous Spar, Barytes, &c.; it is not easy to imagine that Gold, Silver, Antimony, and Titanium, in tender and delicate capillary fibres, could force their way through substances so much harder, nor is there any reason to suppose that these metallic filaments were first formed, and afterwards enveloped by a deposit of the substances before named. Minerals obey the universal and most powerful laws of nature—affinity and gravity. This being admitted, it may be fair to observe the possibility of their having been together in solution, and

influenced simultaneously by those laws; separating from each other, and forming chemical deposits, each after its own peculiar order.

REMARKS.

Having given this brief description of Metals, it may not be improper to say something relative to the situation they respectively occupy in the Earth, before they are brought from it, and afterwards subjected to those necessary operations, in order to become useful.

Gold often occurs in Transylvania and Siberia, in veins of other substances, where it is generally found imbedded, foliated, dendritic, or disseminated often superficially; rounded lumps of it have been found in Ireland, Sumatra, South America, Cornwall, Scotland, &c. which, as well as minute particles called Gold dust, are met with in alluvial soil.

Native Gold varies greatly in its purity; sometimes it is found containing one quarter part of Silver or Copper, or both, and never quite pure.

Platina (though more rare) is found in the same manner. Throughout the Gold district of Brazil I did not see one vein of Gold; and although that precious Metal may sometimes appear in short ramifications (in specimens), yet I did not see or hear of any thing like what

is understood by a vein of any regular continuance filled with Gold * throughout Brazil.

Silver, Native Silver, and Silver Ores, occur with Quartz, Calcareous Spar, &c. filling fissures (veins) in the stratum, also accompanying other Metals, and not unfrequently combined with them. Silver is often rich in Gold, and Gold frequently contains Silver. In the North of England, and more particularly in Devonshire and Cornwall, the Lead Ore contains a considerable proportion of Silver, which is extracted from it. Some varieties of Ore have produced above a hundred ounces of Silver in the ton of Lead. The Lead Ore is accompanied with Fluor Spar, filling and forming what are termed veins, in which are made excavations to great depths, and their produce brought to the surface.

The principal mines of Silver are in Mexico, Potosi, and Peru.

Native Silver and Ores of Silver are of late discovery in Cornwall, as are Ores of Cobalt; both these valuable metals have been thrown away, until latterly, since minerals have become better understood.

Copper Ores, Lead Ores, &c. are extracted from veins of large magnitude, also from those of smaller dimensions; some are called strings, generally branching from the principal Veins or fissures; the richest of which have commonly an east and west direction, (or nearly so) though there are many north and south veins,

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* A specimen of Gold, in my possession, ten ounces in weight; also the finest Crystals of that substance hitherto seen.

but the latter are not reputed to be so rich in metallic substances as the former; these Ores are frequently very difficult to obtain; in many cases, they require a great deal of skill, and extremely hazardous labour. After they are brought from their subterraneous abode, they are dressed, that is, broken to small pieces, and separated, by a tedious process of washing, from other substances which adhered to them, and ultimately submitted to the furnace, before they can be presented in a useful state.

It will appear singular, that although Cornwall has been known as a mining country above two thousand years, yet no notice was taken of the Ores of Copper that were met with in working for Tin, until the beginning of the last century.

How confined must then have been the knowledge of minerals amongst the owners of mines. Thousands of tons of this valuable material remained unnoticed, or served only to mend the roads. Since that epoch, perhaps not less than one hundred millions sterling have been produced from the Copper Ores of Cornwall!! and at a rude estimate Cornwall produces above a million annually in Copper.

So little were the Ores of Lead known (except common blue lead ore) in our time, that both white and green ores of that substance have been for years neglected on the heaps both in Derbyshire and Wales, which have since been turned to a very profitable account; nay, of late years, a road repaired with white lead ore and calamine, has been taken up and smelted!!!

Copper Ores and Native Copper, occur most abundant in Granite and Clay Slate, particularly in Cornwall,

where they are attended with Quartz; but the great mine of rich Copper, at Ecton, in Derbyshire, is situated in Limestone, and is attended with Lead Ore, Blende, Calcareous Spar, and Fluor.

Veins of *Tin* occur only in the older or primitive rocks, as Clay Slate and Granite; they are generally accompanied with Fluor, Pyrites, and Blende. Some are extremely thin, though 50 or 100 fathoms below the surface.

The Ores of Tin present but little variety, nor is it so commonly met with as any of the preceding metals. Yet where it has been discovered it has occurred in considerable abundance. In some places it is mixed with, and forms a part of the alluvial soil, from which great quantities have been washed. In the Island of Banca a thin stratum of Tin Ore lies below the alluvial soil in the valleys, which is worked at a most easy rate, and is productive of great profit.

The most instructive collections for beginners are composed of those Minerals which are in general use, and most commonly met with. It is necessary to observe that the metals present great variety, which must be seen and examined before their character can be so known as to enable the beginner to discriminate them from each other.

The learner, after having perused these pages, will be induced to reflect on the high importance of Mineralogy, or the knowledge of one mineral substance from another. Many kingdoms owe their wealth and their greatness,

to their mineral productions, and individuals innumerable have been enriched by the produce of mines. The washing the alluvial soil, whether for Gold or Tin, is immaterial, if it is advantageous. The Coal we possess is the foundation of our national strength, as well as our riches, and worth to England more than all the Gold mines of Peru, which it has rendered subservient to our manufactories.

It cannot but be interesting and agreeable to the mind to know one substance from another, as Granite from Limestone, or Lead Ore from Copper, although not interested in the pursuit of Minerals.

Even this information would, in many instances, have proved of importance, as Limestone has often been transported to various places abroad, where it has since been discovered on the spot. Slag has been bought for Copper, and Tin for Silver, by early visitors to South America.

It is unaccountable that substances always beneath our feet, and frequently above our heads, have hereto been unnoticed and disregarded even by those who are deeply interested in them.

GEOLOGY.

DESCRIPTION OF THE EARTHS THAT FORM THE SURFACE OF THE GLOBE.

LESSON IV.

EARTHS are commonly understood to be composed of substances neither metallic nor inflammable, though many of this class contain various proportions of the former *, and some are combined with the latter.

The beginner must inform himself of the names of those substances generally called *Earths;* they are but few, and those most commonly met with are only five, viz. the *Siliceous*, *Calcareous*, *Argillaceous*, *Magnesian*, and *Barytic;* to which is added the *Strontian;* none of which have hitherto been met with in a state of purity, being always associated with one or more substances, either chemically combined or mechanically compounded.

These I purpose to treat of in the following pages, and to endeavour to explain their general characters,

* *Iron*, for example, forms the colouring matter of a great many substances, as Jasper, Red Sandstones, Clays, Gypsums, &c. &c.

and the peculiarities which may distinguish them from each other in the common state of their ordinary appearances.

There are three other Earths which are very little known, viz. *Zirconia*, which has only been found in the Zircon and Jargoon, also *Glucine* and *Yttra;* but these seldom occur, and the beginner, who is desirous to know more of them, may consult an elementary work *.

The surface of the globe, mountains, valleys, the bottom of the deep, and the whole united mass of the terrestrial orb, are comprised in the general term EARTH, and are believed to be composed of the four † first named, blended or combined in all the degrees and forms in which the Infinite Power, who created it, has thought fit to present it to our view.

As Siliceous substances are believed to be in greater proportion than any of the others, I will endeavour to shew how they may generally be known.

Siliceous Earth or *Silex* ‡ occurs in great abundance in Granite, which is composed of Quartz and Felspar, a substance dissimilar to the former, and also of Mica, very different to both; these are understood to have been the first chemical deposits, when Earth obeyed the Almighty Fiat, separated from chaos, and formed (the

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* *Barytes*, *Strontian*, *Zirconia*, *Glucine*, and *Yttra*. These Earths are very limited; the first is not uncommon in this country, the next may be said to be seldom met with, and the three others are of rare occurrence. Zirconia exists in the Zircon. Glucine exists in the Emerald, and Yttra in the Gadolonite.

† *Siliceous*, *Calcareous*, *Argillaceous*, *and Magnesian*.

‡ Silex, Lat. Flint. The word Silex has given way to that of Quartz, which will in future be used in this little treatise.

greater part of) the globe, the immense mountains of *Granite* and *Granitic Rocks*, which sometimes alternate with others, supposed to be of the same Primitive—the earliest formation.

Veins or fissures filled, or in part filled with metallic substances, often occur in Granite, and cavities are frequently lined with the most beautiful crystallizations, composed of substances quite different to the rock by which it is bounded. It is also a curious fact, that almost all the great fissures or rich veins have a straight direction, be they in Granite, or in the flat Limestone formation.

Granite forms the highest mountains, some of which are the most rugged and peaked that have hitherto been explored, also the general course of Alpine countries; and the deepest ravines *, having frequently immense tracts of various formations, betwixt its lofty points, forming mountains of different elevations, rocks, hills, and valleys of great extent, or ravines more or less confined. (See plate A.)

Of this almost universal formation (Granite), the sub-

* Imagine a valley of any extent, betwixt two lofty points of Granite, to have been subject to repeated influx and inundations, which have brought together as into a reservoir both animal and vegetable remains; also, the decomposed particles of its confines; such a tract would present a very different appearance from that of *Granite*, and would constitute what is termed the filling up or flat formation †, consisting of stratified and homogeneous deposits.

† Ger. Floetz ferman. See plate.

stance called Crystal or Quartz, forms a predominant part, and may be known from its associates, *Felspar* and *Mica*, by observing the following characters. Some varieties of *Granite* are very small grained, consequently the component parts are more difficult to be distinguished than in others, therefore, I recommend to the beginner, first to examine specimens of the large-grained, in which the three substances may be distinctly seen, and to notice with attention the constituent parts separately.

Quartz (Silex), the immediate subject of our inquiry, has generally a shining lustre, is of a light colour, and not unlike glass; the fracture is uneven, irregular, not of any determinate form; it is sometimes imbedded in Felspar, and when broken across, resembles Hebrew characters. It is commonly opake, approaching white, and not unfrequently smoky, of different shades of brown; these are its usual appearances, though it occurs yellow, pale or deep pink, and approaching to red, also violet, blue. It is hard to the knife, but a good file will make an impression.

Quartz appears massive, also in regular and irregular forms, compressed or aggregated. If diaphanous and very fine, it is then called Crystal, or *Rock Crystal*, some varieties of which are of various colours, as has been before stated. Silex is also in great abundance in other Rock formations besides Granite; Quartz forms extensive veins, patches of great magnitude, skirting or covering Rocks, and there are few metals that it is not associated with.

Silex is so universally diffused, that it would be difficult to say where it is not. Flint, Chalcedony,

Agates, Jaspers, Aggregates, Petrified Wood, Hornstone, Felspar, Clays, Mica, &c. &c. partake largely of this substance; and the very numerous and extensive class called Sandstones, coarse and fine, and of almost every denomination, are composed of it, whether reduced to Pebbles, Gravel, to large-grained Sand, to Sand, and to the finest particles called dust, in which state it enters succulent vegetables, as the stems of rice, &c. to which it adheres in the early stage of their growth, adding strength, and being conducive to the perfecting of the plant.

Felspar * is considered the second constituent of Granite †, and in some varieties it is more abundant than Quartz.

When a piece of Granite is broken, the Felspar in it generally appears as if split or divided, having a smooth flat fracture, and a regular form, or a tendency towards it, which is not the case with Quartz.

Felspar is commonly of a grey colour, and has a shining silk-like lustre; it is often pale red, and then forms Red Granite. It rarely occurs transparent, or

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* This substance, properly speaking, belongs to the Argillaceous Class; but as it is a constituent of Granite, I have thought it best to describe it here.

† Granite sometimes contains a large portion of Hornblende, (see Magnesian Order) which, in some cases, resembles Mica. Tourmaline and Schorl is often imbedded in it, also Precious Stones.

blue, or green; what is called Labrador, or irridescent Felspar, is very beautiful; it exhibits the finest variety of colours, in the same specimen.

Felspar is in distinct crystals or aggregated, sometimes disintegrated; it also occurs massive. It is often in decomposition, when it becomes dull, earthy, and passes into Clay. If these characters are well noticed, Felspar will easily be distinguished.

Mica, the remaining constituent of Granite, is of a yellowish colour, and has a strong metallic lustre; it is composed of delicate foliæ, splitting or separating as thin as fine paper, and is extremely elastic. In mass it has frequently a smoaky brownish tinge, but in laminæ is generally transparent, and used to cover objects for the microscope; it is employed in Russia for windows, and called Muscovy glass. It is often seen in soil, at the bottoms of rivulets, in South America, and many have brought it from abroad, believing it to be gold! Mica is soft, easily scratched by the knife, and produces a white flaky powder. It belongs to the Magnesian order; but as it forms a constituent of Granite, I have thought it best to explain its characters to the beginner, after those of Quartz and Felspar, as they are commonly associated together.

THE ARGILLACEOUS ORDER,

Is considered next in abundance; it commonly appears in the form of Clay, and is more or less indurated.

Primitive Schistos, or *Clay Slate*, belongs to it, which often presents itself, alternating with Granite; it abounds with veins filled with Quartz, Fluor, &c. also many and various metallic substances. Clay slate is of a dull dark colour, bluish black; lamellous; splits freely, absorbs moisture, has an earthy smell when breathed upon, and cannot be mistaken after being once examined.

Primitive Porphyry is very hard and compact; colour red brown, with angular spots of a faint yellow. It occurs dark green, with patches lighter coloured. The variety called Egyptian Porphyry is the most valued.

Green Stones, from containing a great portion of Felspar, belong to this order; and though they are so intermixed with Hornblende, which is frequently in minute particles, yet the Felspar may be known by its lustre and flaky appearance. It is very difficult to determine the relative position of many varieties from specimens; they generally belong to the order of Sienite.

Basalt, *Trap*, *Grau-wacce*, *Toad-stone*, and *Shale*, contain a large portion of Argill.

These substances, when decomposed, (to which many varieties are so subject) form Clay. The Felspars produce the finest, which is used to make China and the best earthenware. Clay-slate, Shale, and the coarse varieties, when decomposed, are used by potters, and for making bricks. The beginner may discriminate common argillaceous substances merely by wetting, and their becoming tenacious, or by breathing on them, when they give out an earthy odour.

LIMESTONE.

Primitive Limestone occurs in beds, or filling fissures in the Granite formation. It is granular and crystallized, also compact, as that from the Isle of Tiree. It does not contain any animal remains or vegetable impressions; it is not very common amongst the Primitive Rocks, neither is it abundant, in the Transition formation; in which it sometimes contains traces of petrified organic remains.

In the Secondary, or what is termed the Flat Formation, Limestone is very generally distributed, forming mountains comparatively of less magnitude, vallies, and plains; it has a regular stratified appearance, shewing evident signs of deposit at different and distant periods. Limestone appears in great part to be formed of Marine petrifactions.

These mountains, though of small extent, present perpendicular and very rugged features, as if separated from each other by some violent concussion, dislocating their strata, and in many situations, throwing them

in great confusion. In this formation are situated fissures and veins of great depth and magnitude, which are filled with metallic substances, generally Lead Ore, and accompanied with Ores of Zinc, Barytes, and Calcareous Spar. There are instances of veins being worked in this Limestone from two to four or five miles in length, producing an immense quantity of lead.

Those Limestones which take a good polish are called Marble, they consist of innumerable varieties; the black is most esteemed, and the best in this country is in Derbyshire, near Ashford, where mills are erected for working it; also at Derby, both of which are in the possession of Mr. Brown.

Chalk belongs to this order; it pervades a considerable extent of country, and is too well known to need any description.

Gypsum, *Alabaster*, is Lime combined with sulphuric acid*. It is very abundant in Derbyshire and Nottinghamshire, and forms a considerable extent of country, filling cavities in the Red Marl, and rising into low hills. It is soft, may be scratched by the nail, which sufficiently distinguishes it from Marble.

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* Lime, combined with Fluoric Acid, forms the beautiful fossil, called Fluor; that variety from which such elegant and beautiful vases are made in Derby, is peculiar to one mine. Fluor has generally a cubic form. Fluoric Acid attacks and corrodes glass, which no other acid acts upon.

Selenite, a crystallized and transparent variety, is sometimes found detached, and probably owes its origin to decomposed Pyrites.

After the preceding Earths, so generally distributed, the *Magnesian* claims our attention; it does not occur by any means, in so great a proportion as the others; on the contrary, it may be deemed scarce.

MAGNESIAN ORDER.

The substance called Serpentine belongs to it, which occurs at the Lizard, in Cornwall, in a tract several miles in extent; another variety is found in Scotland; it is also met with in other countries. Many of the Traps and Amygdaloids contain portions of Magnesian earth, which may be known by their being slippery or greasy to the touch; Mica, Talc, Asbestos, and the soap-like substance, Steatite, contain large portions of it.

Hornblende, a substance very generally diffused, forms a part in Granitic Rocks, as Gneiss and Sienites, also in Serpentine; it may be known from Mica on being gently struck with the small end of a hammer, so as to abrade it, or scrape it with a knife, and a dull green powder will be produced; it contains a large portion of Iron; it is very abundantly disseminated in Basalt, Trap, Amygdaloids, and Green Stones; when in decomposition it is ferruginous, and frequently gives the red colour to Clay, particularly if associated with Felspar.

Barytic Minerals form so small a portion of the Earth's surface, that they rather belong to the class of fossils, and though by no means scarce in this country, yet they are so limited, as not to admit of the most distant comparison with any of the preceding; they are commonly found in veins, and may be known by their great weight. They yield to the knife, and are frequently massive; of an earthy texture, resembling Chalk, also crystallized and transparent. Barytes is an alkaline earth, and becomes caustic on being exposed to a strong heat.

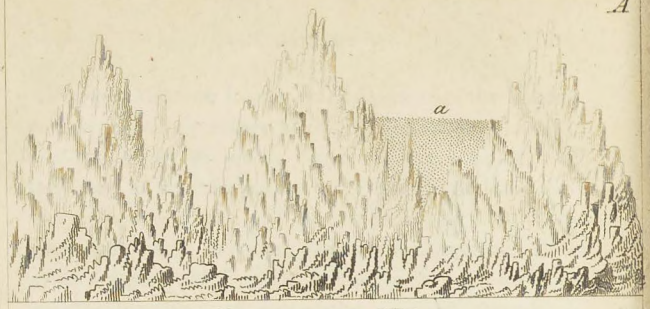
A variety, called *Carbonate of Barytes*, is more rare; it has generally a striated and diverging fracture; is very compact, and, as Common Barytes, may be known by its great weight.

Strontian is an Earth newly discovered; it resembles Barytes in some particulars, but it is not so heavy, and is generally of a sparry texture; often of a very light blue colour, and is then called *Celestine;* it occurs granular, fibrous, and earthy.

Another variety, called *Carbonate of Strontian*, is light green, striated; it is generally accompanied with Earthy Barytes, and is very rare.

Carbonate of Strontian may be known by mixing a little of it in the state of powder, with Spirit of Wine, which, on being set on fire, produces a beautiful purple flame.

A



Primitive Rocks.

B

Primitive Rocks & Secondary.

C

Stratified Rocks. Floetz Formations and alluvial deposit.

J. Cross sculp.t 12 Carsitor Street.

DESCRIPTION OF ROCKS,

WHICH COMPOSE WHAT IS TERMED THE

PRIMITIVE FORMATION.*

LESSON V.

After having described the Earths as they commonly occur, it will be proper to explain what is meant by the word formation, when applied to Earthy substances.

Geologists agree that there are certain Rocks more ancient than others, and have denominated those which are considered the oldest, *Primitive Rocks*. Thus, those

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* The word Formation is meant to convey to the mind of the learner that the crust of the earth has been formed at different and distant periods, hence each period is called a Formation, as the Primitive, Secondary or Transition, Floetz or Flat, and Alluvial.

Geological Collections may be obtained at a cheap rate, with the name and description of each specimen, explaining to what Formation it belongs, by which the learner will be enabled to determine the substances he may generally meet with. These collections, on a small scale, will be interesting to those who read books upon Geological subjects, and may be purchased at from Two to Ten Guineas. The time necessary for selecting, arranging, and describing, forms a considerable part of their cost.

of Granite, &c. are said to be of the Primitive Formation, whilst others are considered of the Secondary or Transition, and a third class are styled the Floetz or Flat Formation, being formed upon the Primitive or Secondary, and bounded by rocks of that description.

It is not my intention to point out where these Rocks are to be found, except in particular cases, nor do I think it necessary to enumerate *all* their varieties, but to explain to the beginner the characters by which they may be known, after having examined a few specimens without entering into the particular form of the substances which compose them; therefore, as Granite is considered of the first or oldest formation, I shall commence a general and brief description of some of its varieties.

Although the Crystals of *Quartz*, *Felspar*, and *Mica*, are commonly so confusedly aggregated, and intermixed with each other, yet they often occur distinct, particularly on the surface of pieces wrenched from hollows or cavities, therefore, in order that the learner may have a correct idea of these substances, I will place them separately.

Quartz. Crystallized, or in fragments.
Felspar. Idem.
Mica. Idem.

Granite, composed of large crystals, of Quartz, Felspar, and Mica, distinctly or confusedly aggregated, as the Grey Granite, on Dartmoor.

Granite, common variety, neither large nor small

grained, being composed of Quartz, Felspar, and Mica, in regular proportions.

Granite, small grained; often occurs with Garnets imbedded in it.

Granite, composed of bronze coloured or dark smoaky Mica, sometimes almost black; the Mica predominating.

Granite, GRAPHIC, is composed of long crystals of Quartz, imbedded in Felspar, and when broken across, exhibits Hebrew-like characters, hence called *Literatus*. In this variety the Felspar and Quartz shew their characters very distinctly, and the Mica occurs in thick patches.

Red Granite, so called when the Felspar predominates and is of a red colour, it is common in Scotland; the Cathedral, on the Isle of Icolmkil, is built of it.

Granite, the Felspar of which is disseminated and decomposing, or quite soft, forming Clay; the Mica and Quartz appearing unaltered *.

Granite, composed of Felspar and Quartz, approaching granular, with Hornblende disseminated, and a small portion of Mica, also contains large and perfectly defined Crystals of Felspar imbedded. This variety is called

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* Felspar contains more or less Alkaline matter, which subjects it to decomposition.

Moor-stone in Cornwall, and some have named it Porphyritic Granite; it may be seen in the pavement of London, particularly after rain, the Crystals of Felspar protruding above the surface. This variety differs much in the proportions of its constituent parts, and often approaches SIENITE. Garnets, Tourmaline, and Schorl, are frequently imbedded in it.

White Stone, is fine-grained, consisting chiefly of opaque Felspar, sometimes having the appearance as if in decomposition; it is associated with Quartz and Mica, and probably a variety of Granite.

Gneiss, is Quartz, Felspar, and Mica, the latter laying parallel, forming thin beds, and has been called slaty or stratified Granite.

Another variety is, by some Geologists, called Gneiss, when Hornblende forms a constituent, without regard to its lying in laminæ.

Sienite is Felspar and Hornblende; it is commonly very hard and of a dull red colour, as that at Mount Sorrel, in Leicestershire; it occurs also grey and dark green. Sienite is not very abundant, and is often taken for Granite. The grand head of Memnon, in the British Museum, and the colossal figures in Egypt are called *Sienite*.

Sienite, when composed of more Hornblende than Felspar, is often called Green Stone, of which there are many varieties, indeed the term Green Stone depends much on the colour. Hornblende is a constituent of several Granitic Rocks.

Topaz Rock is a variety of Granite, of a slaty texture, like Gneiss, with Topazes and Rock Crystal imbedded in it. The Felspar is frequently decomposed, forming clay.

Mica Slate, is Mica and Quartz laminated, or Mica disseminated and in small particles, having a slaty texture; it is abundant, and frequently Garnets, Schorl, and Precious stones, are imbedded in it. Mica Slate has often an undulating and curved appearance; in some cases it appears wholly composed of Mica. This variety consists of very fine particles, which pass into clay. The Topaz mines in Brazil are in this substance.

Quartz Rock is both massive and granular; it frequently contains Mica, and sometimes Talc, a substance resembling Mica, also often large portions of Tourmaline and Schorl, and is then called Schorl Rock. Garnets and Pyrites are commonly imbedded in it.

The following Primitive Rocks probably were not formed at the precise epoch of the preceding.

Clay Slate is next in abundance to Granite, and often alternates with rocks of that order, forming mountains, filling hollows, &c. It is called Killas in Cornwall, and in it many metallic veins occur, particularly those of Tin and Copper, also Lead; the latter is commonly rich in Silver. Clay Slate is generally of a dark colour and earthy; it is also slaty and shining, sometimes appearing as if composed in great part of fine particles of

Mica; these varieties soon decompose. Slate used for roofing and paving, belongs to this order; in it Pyrites and Rock Crystal are frequently imbedded.

Flinty Slate is hard, of a black colour, and compact; splits slaty, and occurs with Clay Slate; it differs from Flint by being opaque, and is of a different texture; it contains small veins of opaque white quartz.

Porphyry. What is commonly understood to be Porphyry is a hard red brown substance, enveloping, or containing crystals imbedded in it, which are generally Felspar of a light colour; this variety is called Red Egyptian Porphyry. Green Porphyry is of a dull dark green, with crystals of Felspar of a light green colour, and has been called Ophites. Brown Porphyry, as that from Sweden, resembles the Egyptian, though it is not so red.

There are other varieties of Porphyry, as Pitch Stone Porphyry, Green Stone Porphyry, Hornstone Porphyry. Any Clay-like indurated mass, enclosing distinct crystals of another substance, is commonly called Porphyry.

Jaspers of various colours and descriptions often fill fissures in this formation, and constitute veins.

Jaspers are commonly hard and fine grained; generally of a red colour, often striped, and contains a large portion of Iron.

Serpentine * is not very abundant in this country, and

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* *Serpentine.* This class is of various colours, sometimes resembling the skin of serpents, hence its name.

when associated with Primitive Rocks, it is considered of the same formation. Serpentine is commonly dark coloured, brown red, with reddish marks, or dull green, variegated; it occurs also lighter or darker, often spotted, sometimes with splendent shining Hornblende. Some varieties appear compact, like Talc: but after examining a few specimens, it may generally be known by its variegated colours, and being soap-like to the touch; when breathed upon, it gives an earthy odour. It is soft to the knife. Veins of Talc, Steatite, and Asbestos, frequently occur in it.

Primitive Trap. The substances of this formation are composed of minute crystals, almost wholly of Augit or Hornblende; they are of a dark colour, approaching black; very hard and compact; some varieties contain a larger proportion of Felspar, which may be distinguished by its lustre, and being of a lighter colour. It differs every way from Sienite, which is probably owing to the chemical state of the Hornblende.

Green Stones, composed of Felspar and Hornblende, belong to this formation when associated with Primitive Rocks, and may be distinguished from those (Green Stones) of the Secondary Formation, by being more distinctly crystallized, and harder; they differ from Sienite principally in colour, and are considered to contain a greater proportion of Hornblende, which is of a lighter shade.

Primitive Limestone is granular, as Dolomite and Statuary Marble, or compact, as the Limestone from Tiree, where it occurs of a beautiful flesh-red colour, enveloping Sahlite and Titanium. It effervesces with

acid, and always yields to the knife. Another variety, from Scotland, is of a clouded pale green; it is extremely hard, and of close texture. The learner will know, before he has read thus far, how to discriminate Limestone from any other substance.

Primitive Gypsum is soft, yields to the nail; it is both granular and compact, associating with Primitive Rocks. The Italian Alabaster is said to be Primitive. As a formation it is of little importance, and occurs filling cavities of small extent.

Every day new substances are discovered, imbedded in Granite or Granitic Rocks, as Tantalite, Lithon, Spodumene, Fettstein, Zircon, &c. &c.

The Primitive Formation may be supposed to have been split in all directions, and without any regular order, presenting the most rude and pointed elevations; before the creation of vegetable matter, and before decomposition could take place. Such mountains may be supposed to be represented in plate A, which is intended merely to give the learner an idea of rugged Alpine scenery. A valley may be supposed filled with deposits, as Blue Clay, Sand, &c. as *a*. The greater part of the Globe yet being covered by Sea, great alterations and changes must be constantly taking place.

This short account of what are termed Primitive Rocks, when understood, will enable the learner to de-

termine and distinguish them from those of other formations; but it is necessary to observe, that hollows, rents, or fissures, in this formation, may be filled, not only with metallic ores, but with varieties of their own Rock species, as Granite, Sienite, Porphyry, Jaspers, Hornstones, Green Stones, Calcareous Spar, &c. &c.

Clay belongs to every formation, being the result of decomposed Felspar, Porphyry, Green Stone, Trap, Rocks, and Serpentine.

Observations

ON

THE SECONDARY FORMATION.

See B. Plate A.

LESSON VI.

THE Globe being formed, Land and Water separated, the natural result of Time, would evidently produce great changes; thus the disintegration and decomposition of the Primitive Rocks, both above and below the sea, the action of the atmosphere, and various deposits of which we have but little idea, must have produced other formations before, and in part after, the Creation of Animal and Vegetable Substances; but it is a received opinion, that they were not in abundance during this epoch. The substances belonging to, and arranged in this formation, are termed, by Geologists, Secondary Rocks, and may be considered partially mechanical as well as chemical deposits; they are called *Grau-wacce*, *Transition* or *Secondary Limestone*, *Transition Trap*, and *Transition Flinty Slate;* of these the Grau-wacce appears the most extensive.

Grau-wacce is a mechanical deposit*; that is, it is supposed to be an aggregate cemented by Clay, and composed of the debris of the Primitive Formation, whether coarse, fine, compact, slaty, granular, &c. *Grau-wacce* must, therefore, be considered extremely different in its appearance and texture, as, from its nature, its constituent parts are very various. Its colour is generally dark, dull, often greyish, and its base is argillaceous, cementing together fragments of the older rocks, grains of sand differing in size, angular and rounded Pebbles, also patches of indurated Clay or Flinty Slate, and has sometimes, when composed of fine particles, a slaty texture; it is hard, of considerable extent, and highly metalliferous. It is difficult to describe Grau-wacce, so as it may be known. It is necessary to see some well defined specimens before a correct idea of it can be obtained.

Grau-wacce Slate is considered in more abundance; it is finer grained, and has a slaty texture.

Secondary Limestone is generally considered that which is associated with other Rocks of the same formation, connected with those of the Primitive; this Limestone is perhaps a deposit more mechanical than chemical, and is scarcely to be called granular; its texture is fine, and its colours very variable, and frequently strongly contrasted, as red, black, white, yellow, &c.; it is abundant in Devonshire, both at Torbay and Plymouth, where it exhibits marks of stratification; slabs of it, when polished, are very beautiful; the streets

* A substance formed by the disintegration of others, or intermixed with organic remains, is called a Mechanical deposit.

of the town of Dock are paved with it. In the north of Devonshire, near Castle Hill, this variety of Limestone occurs, filling large cavities in Grau-wacce slate. In it are many sparry white veins, and abundance of Pyrites. Marine fossils and petrifactions occur, but not of the same description, nor in any degree so abundant, as in the Limestone of the Flat or more recent formation. The learner will discover Limestone either by its effervescing with acid, or by burning a small particle of it to Lime.

Patches and beds of green stone irregularly occur with this Limestone.

Secondary Trap. This formation may be considered to consist of what is more commonly termed Green Stones, which are very abundant. The constituents, Felspar and Hornblende, are less crystalline than in the Primitive.

Green Stones, belonging to this order, form great variety; some of them are in part mechanical as well as chemical deposits; they differ from Sienite, the component parts being less distinct, and more blended together. They are commonly of a green colour, and frequently contain veins of Quartz; they are sometimes dark, approaching black.

An indurated substance, of an earthy dull appearance, vesicular, and partly decomposed, is called Wacce. Being cellular and scoria-like, it has often been supposed to be of volcanic origin, without considering that such vesicles may have been formed by air or water, or by the decomposition of some alkaline substance.

Amygdaloid is another variety, containing almond sha-

ped nodules of Chalcedony, Zeolite, Green Earth, Agate, Jasper, and is often vesicular. It occurs hard, soft, and earthy, according to its state of decomposition; further description will avail the learner but little; specimens must be examined, to be known. This variety is considered to be formed with Grau-wacce, and occurs, filling cavities, and skirting the Primitive Formation, and the exterior of Trap Rocks.

Trap is the Swedish term for ladder; some Green Stone Rocks, Basaltic Rocks, and Hornblende Rocks, commonly appear as forming steps, hence Trap, ladder. It is particularly visible at Staffa, and in various parts of Scotland, and other places. Rocks of this class decompose into clay, the exterior of which are frequently soft and ferruginous, and the interior unaltered.

Transition Flinty Slate, is a siliceous flinty substance; it occurs in thin strata, with Grau-wacce and secondary Limestone; it is compact, and marked by alternate lines stratified, of a dark or lighter colour.

Of this, the Secondary Formation, Grau-wacce may be said to be the only one that is metalliferous; in it are situated many strong and large veins of Lead Ore. The Grau-wacce formation is no doubt more extensive than has hitherto been suspected, and substances now known by other terms, will probably come under this denomination.

The engraving B, plate A, is intended to shew Primitive Rocks, blunted by decomposition, and the Transition Rocks, forming from their disintegration upon their bases, skirting them.

It is by no means improbable but that many more varieties will be ranked in this formation, when our ideas become unfettered, and our reason has fair play, in opposition to theory, which it is now the fashion to follow.

Nor is the following arrangement free from objection.

FLŒTZ, OR FLAT FORMATION.

C, PLATE A.

This formation is supposed to be more recent than either of the preceding, which may be said to be formed by deposit (chiefly mechanical) from the debris of the others, and the result of organic remains; resting upon the Primitive or Secondary, having been formed at various epochs, and by various operations, filling or rendering more flat extensive valleys between elevated Rocks of the Primitive class. This order is very general throughout a great part of the globe, and shews evident signs that it has been (a deposit) formed under water, after which violent convulsions have taken place, from the visible great irregularity of the strata.

It is my desire to endeavour to explain the substances which compose this formation, so that they may be known from others, rather than attempt to account for the manner in which they were produced.

The plate C is intended to exhibit the appearance of stratified rocks, as Limestone, *a*, *b*, *c*, also a section of a vein of Lead Ore; the figures *f*, *f*, shew the separation and dislocation of the stratum; this Limestone is considerably below the Coal.

The beds of Coal are represented by *d*, *d*; they are in-

dependent of each other, having indurated Clay or Sandstone between them. The surface *e*, *e*, *e*, *e*, is intended to shew the Clay basins, Sand hills, Gravel, and Alluvial Deposits.

The Coal formation is attended by petrified stems of Plants, and numerous Vegetable impressions, imbedded in Clay Iron Stone; also fresh-water Shells, which indicate its origin to be very different to the preceding.

Following the Wernerian arrangement, the first deposit belonging to this formation is of great extent, and called

Old Red Sandstone, or Sandstone of the first flœtz formation. It is supposed to rest upon some of the preceding, and to be composed of their debris, particularly Grau-wacce, with which it is often connected, frequently having more the appearance of decomposed Clay Slate than Sandstone; it is commonly red-coloured, approaching earthy; in some places it is of great extent, and interposes betwixt the Secondary Formation and Flœtz Limestone. It rarely contains mineral substances or fossils.

First Flœtz Limestone. Is supposed to have the old red Sandstone beneath it, and to be formed after the creation of marine animals; it is of great thickness, regularly stratified, and composed of petrified Shells, Coral, and Marine Exuviæ; it is hard and compact, presenting lofty mountains and deep ravines, exhibiting evident signs of having undergone violent convulsions, from the dislocation of the strata; in it are peculiar

beds * of great beauty from the figures they exhibit when cut into slabs and polished; granular Limestone has occasionally been met with. The learner, on examining, will determine it a Flœtz Limestone, from being almost wholly composed of marine remains. This formation consists of innumerable varieties, and is of very great extent.

First Flœtz Gypsum sometimes contains Crystals of Quartz and Boracite, and is generally associated with Rock Salt; in texture it is so like other varieties of Gypsum, that it cannot be known, except when seen in its situation.

Second, or Variegated Sandstone, is a deposit of fine granular sand, in great regularity, and often coloured red, yellow, and brown; it is moderately coherent, and contains a considerable portion of clay with oxide of iron.

Second Gypsum. This consists of varieties more or less compact; it occurs filling cavities in the Sandstone formation, accompanied with red marl; it is frequently fibrous, and less hard than the preceding varieties; in Gypsum no Metallic Substances have been hitherto observed.

Shell Limestone is, as its name explains, a Limestone almost composed of Shells, of more recent formation; its colours are various; it is sometimes sparry and

* This Limestone is marked with distinct lines of stratification, and each division is called a bed, some of which are in greater request than others.

foliated, but more generally earthy; it is abundant in Gloucestershire, and contains a large portion of Magnesia; in it are beds of the Oolites (roe stone); it may easily be known from any of the preceding varieties by being softer, less compact, and often having a sparry lustre.

Third Sandstone. This formation is of considerable extent, and may be considered that on which the Coal rests. Its appearance, where it forms the surface, is generally rugged, exhibiting rocks of great irregularity. In it are beds of different texture; some are laminated with Mica, and are used for paving, roofing, and other purposes; lead ore sometimes, though rarely, has occurred in it.

Rock Salt is generally of a red brown colour, rarely blue, sometimes perfectly transparent, and has commonly an ice-like appearance; it rests upon Sandstone, and is often associated with Gypsum; great variety of Grit Stone, Clay, and semi-indurated earthy substances are formed above it.

Chalk. This formation is of great extent in this country, also on the continent, particularly in France; the margin of the English Channel is in several places formed of this substance, which is too well known to need any explanation; in it are regular beds and nodules of Flint. This singular variety of the Limestone formation, contains innumerable marine petrifactions. Hereto no metallic ores, except Pyrites, have been discovered in it.

Coal. This substance, so useful and of such high im-

portance to this country, is too general to require particular description. Coal is compact, as Canal Coal, or Foliated Shining and Slaty ; there are also earthy varieties. Canal Coal has in many cases a wood-like structure. Foliated Coal frequently contains thin layers of Charcoal, in delicate fibres. Coal is commonly formed in beds of different thickness, from two to five or six feet and more. Each bed is separated by Sandstone, bituminous clay, more or less indurated, and both are frequently blended together.

Sandstones, of the Coal formation, are variable in their texture and composition ; some are hard and tolerably compact; others are soft and earthy; they soon decompose on exposure to the weather, having generally a Clay base.

Peculiar sandstones above coal, are common indications of its position, from whence may be conjectured its depth : for it is reasonable to suppose, that if certain sandstones attend coal in one situation they *may* be found to do the same in another.

FLŒTZ TRAP FORMATION.

The substances comprehended in this order, are in general supposed to be coeval with the Coal Formation, which they frequently obstruct and dislocate, throwing the beds into great disorder. They often occur in large fissures, called *Whin Stone Dykes*, and in smaller, called veins, frequently traversing Rocks of the Primitive, Secondary, and Flœtz Formations; there can be little doubt that some of the varieties belong to older formations

It is in this order that volcanos are supposed to have

their origin and their existence: the learner must be aware that there is a great difference betwixt Rocks that have been subject to or altered by Fire, and what is termed Lava.

The general characters of some of the following substances have been before noticed, therefore I will be brief, and explain those which are understood to belong to this formation.

Basalt. When a simple substance, resembles an indurated ferruginous Clay, of a dark colour, approaching black, and is often columnar. Some Geologists consider this order to be of Volcanic origin, or having undergone the action of fire. In it minute crystals of Hornblende, Olivine, and Augite, frequently occur.

Clink Stone appears to be a variety of the preceding; it is a fine compound of various substances, and cemented by an argillaceous base, sometimes containing crystals of Felspar, and forming imperfect Porphyry. It is of slaty texture, colour various, generally dull, bluish, or dark green, approaching black, sometimes waved, sounds like metal when struck.

Trap, frequently confounded with Basalt, is a compound of Black Iron Sand, Hornblende, Felspar, Marl, and extremely fine particles of Mica cemented by a Clay base, which often contains small nodules of Zeolite, Chalcedony, Jasper, &c. Its constituent parts are frequently very numerous, being formed from the debris of the older Rocks; veins of Carbonate of Lime occur in it. In decomposition it assumes various appear-

ances, often resembles the scoria from a furnace, and finally passes into Clay.

Whin Stones. The substances belonging to this order are different in colour, texture, and composition; they may be considered in part chemical, but chiefly mechanical deposits, consisting of particles of various substances, as Hornblende, Felspar, Quartz, Marl, Clay, &c. They are hard, and difficult to break.

Trap Tuff is formed by fragments of the preceding varieties, cemented together by an earthy clay-like deposit, and forms a coarse aggregate.

Green Stone. Of this order it is difficult to say where they begin or where they end, as any substance with a greenish tinge is commonly called Green Stone. Those belonging to this formation seldom exhibit distinct crystals of Felspar; but generally are granular, and often have an earthy appearance: they contain a large portion of Hornblende; Agates and Jasper occur embedded in this substance.

Pitch Stones are said to belong to this order; they are not so heavy as Jasper; their colours are dull shades of red, brown, and green; sometimes they contain Crystals of Felspar imbedded, which variety forms Pitch Stone Porphyry.

VOLCANIC SUBSTANCES

Are those which are wholly or in part altered by fire; they consist of great variety, and are peculiar to countries where volcanos are met with, or have at some former period existed. The substance that flows from them is termed Lava, which is either compact, slag-like, or cellular; it often envelops Crystals that are unaltered by the heat they have undergone.

Earthquakes, that have shaken the globe, ingulfed whole districts, and changed the appearance of nature, forming mountains where plains existed, and have thrown the whole system into the greatest confusion, are generally supposed to be the result of Volcanos.

THE ALLUVIAL DEPOSIT

Consists of loose Stones, Sand, Clay, Loam, &c. This formation may be said to cover the general surface of the Earth, as it comprehends every description of soil and disintegrated earthy substance. It is sometimes of great depth, and regularly stratified. In it occur Vegetable remains, Wood Coal, Peat passing into Coal, Bones, Shells, &c.

Alluvial soil is often moved by inundations, and its finer particles are sometimes carried away by heavy gusts of wind, in such cloud-like appearances, as to change the face of the country; nor is it uncommon for herds of cattle to be buried in it.

In this Alluvial Deposit Diamonds and Gold are found in Brazil, Africa, and India; the same formation produces immense quantities of Tin in the Island of Banca, also in Cornwall, where Gold is found in small particles.

This Formation demands more investigation; it is naturally composed of the debris of the solid contents of the globe, and substances found in it have led to important discoveries.

The method which the author has followed in the foregoing pages is considered to be the least objectionable, and as he is desirous that the learner should distinguish the various substances belonging to each order, it will be best for him to follow the beaten path, until he is able to discover a better road. Many have projected theories, some of which are more accredited than others; but none are free from very great objections.

Description

OF

COLOURED PLATE.

A BRAZILIAN MINER WASHING THE ALLUVIAL SOIL FOR GOLD AND DIAMONDS.

This plate is taken from a view in Cerro de Frio, in Brazil. The situation is a ravine, through which a stream of water runs, called Mielho Verde; it is bounded by mountains of Granite, large blocks of which lie in all directions.

In the summer season a part of the bed of the rivulet becomes dry, and often the course of the stream is changed by placing planks, in such a manner, as to lay bare the other part, in order to remove the gravel or soil which has been deposited after heavy rains; for this purpose people are employed in digging, raking, and carrying it away to the nearest plain, where they throw it into a heap. It is generally observed that the soil nearest the solid rock is most abundant in grains of Gold and Diamonds, consequently the surface of the rock is scraped, and not an atom of the Alluvial Deposit suffered to remain. When the rains commence, and the water is in sufficient abundance, the most skilful

miners are employed in carefully washing this soil in small conical bowls: the operation is performed as follows: the bowl being in part filled with water, about ten or twelve pounds of the Gravel is put into it, which is continually stirred about until the rounded stones become clean; as the water becomes muddy from the earthy matter being held in solution, it is poured off, and fresh is continually added, until the whole is washed, so as no longer to render the water turbid; then the larger stones are thrown away, and the smaller ones picked out with great care, below which the Diamonds will be found, and at the bottom the grains of Gold will appear, generally accompanied with Iron Sand. The Diamonds are more easily distinguished when wet, having a peculiar semi-metallic lustre.

Gold and Platina, whether in larger or smaller grains, being so much heavier than Pebbles, or the earthy substances in which they have been imbedded, fall to the bottom of the bowl as soon as the earth is washed from it.

The plate represents a smuggler at the heap, by stealth, as, wherever Diamonds are found, the crown claims the property. Frequently men go ten or twelve miles in the night, and take a sack of this Gravel, which they wash at home secretly. This is what is called hand-washing. There are other modes practised on a larger scale, which are more expeditious, but not so economical. I have seen eight men procure upwards of twenty ounces of Gold in four hours, from a portion of soil not above two tons, which was taken from a deep hole which occasioned an eddy in the river.

COLOURED PLATE.

SECTION OF THE STRATA AT MATLOCK HIGH TOR.

THE Section of the Strata at Matlock High Tor, represents the general strata of Derbyshire, from the coarse Grit down to the lowest Limestone. The reader may suppose himself on the road, and looking down the river; then the broken mountain of Masson and the Cumberland mine will be on his right hand, and the perpendicular face of the High Tor will be on his left; above which, further back, on an eminence called Riber, (out of sight) is the stratum of coarse Gritstone (*a*), which is below the coal measures. This Grit is generally of a light grey colour; it is composed of Crystals and rounded fragments of Quartz with Felspar disseminated, and crystallized, having the decided characters of a mechanical aggregate; in it are a few traces of Schorl and Mica; but the Felspar being crystallized, allows reason to suppose it is in part a chemical deposit, which is often the case in compound rocks of this description; it is of considerable thickness—in some places upwards of fifty fathoms; valleys are bounded by it on one side, whilst Limestone forms the other, which indicates that the strata have undergone great changes. This stratum rests upon Shale, and where they approach

each other, the Grit becomes lamellar, soft, and often contains thin beds of Schistos.

Bituminous Schistos. Shale (b) forms a stratum equal in depth to the preceding; its colour is dark, almost black; it is earthy, and though tolerably hard, yet when exposed on the surface, divides in laminæ, and decomposes into Clay; it has the appearance of being entirely a mechanical deposit, containing some fossil shells and vegetable remains, as stems of trees, impressions of plants, and Clay Iron Stone. Some varieties are so bituminous as to burn, and have been used in limekilns. It appears a compound of fine sandy particles, ferruginous Clay, and Marl, with a great proportion of decomposed vegetable matter. In it are many sparry veins, and frequently fissures of considerable magnitude, filled with Lead Ore and Calcareous Spar, which have been worked in this stratum. This Schistos or Shale rests upon Limestone, and where they are in contact, they partake of the qualities peculiar to both.

The First Limestone (*c*), which forms the summit of Matlock High Tor, exhibits marks of regular stratification, and is of a grey colour, appearing almost composed of marine remains; in it are numerous veins, filled with Lead Ore and beautiful crystallizations, which commonly divide the stratum in an east and west line; but there are others that cross them, and of course have a more northerly and southerly direction. The veins are often obstructed, and cut off by the abrupt intervention of the Toadstone stratum below; *(v)* is a mine or vein of Lead Ore now worked.

Toadstone (d). A stratum so called may be seen about the middle of the High Tor, dividing the Limestone; its colour is dull, texture earthy; contains Pyrites, and is spotted green; this substance contains some Lead Ore *. Another description of *Toadstone* is more generally met with in this neighbourhood, which is hard and compact; it appears to be composed of indurated ferrugineous Clay, Sand, &c.; in it are traces of Jasper and Chalcedony; sometimes it has the appearance of Basalt: in this no trace of marine or organic remains have been discovered, nor any Lead Ore: in decomposition it forms Amagdaloid, and finally passes into Clay.

This Toadstone does not admit water to pass through it, but when in contact with Limestone, the appearance of both are greatly altered; above and below their junction several feet of each exhibits very different characters from those of their usual appearance; it is difficult to determine if the miners have not mistaken the change of the character of Limestone, when in contact with Toadstone, or if the continued action of water may not have caused Lead Ore to have passed from the vein and penetrated into the latter, either mechanically, or from being held in solution. It is my desire to state facts, rather than conform to theories, and I hope that this important desideratum will soon be satisfactorily attained.

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* It is possible that a thin bed of Toadstone, situated betwixt Limestone, may have become so altered, as to lose its general characters; it is also possible that the Limestone may contain a large portion of Pyrites, Magnesia, &c. so as very much to alter its appearance, particularly if in decomposition.

There is not the least reason to suppose this substance is of Volcanic Origin, although it has often, in decomposition, a scoriæ-like appearance, but very different to lava. Yet it is true that it separates the limestone and the veins of lead ore, where they occur in contact, which has not hereto been satisfactorily accounted for.

Underneath the first Toadstone is what is termed the

Second Limestone (e). In its general appearance not unlike the first: it is composed of marine remains, and in it are beds of Magnesian Limestone; the veins of Lead Ore that were intersected by the Toadstone, appear again, with all their former richness and characters; *(l)* is a level driven from the edge of the river to carry off the water from the mine: this Limestone varies in thickness, and is divided by a second stratum of Toadstone, which forms the bed of the river *(r)*, rising to the west, and appearing above the celebrated RUTLAND CAVERN, formerly called Old Nestor Pipe *, *(f)*, which is situated in the Second Limestone (G), the entrance into the Cavern. Not a vestige of the First Limestone, nor the great Stratum of Shale, nor that of Grit, appear on the west side of this ravine.

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* Pipe is the usual term for a flat vein: this vein branches, and from it the famous Rutland cavern appears. This cavern is by much the grandest, and most romantic of any in this neighbourhood, the roads being perfectly even; it is easy of access, and produces some fossils peculiar to it, and others of great beauty.

The Second Toadstone (g) does not differ from the first, so that one can be distinguished from the other, except in some peculiar stage of decomposition; when forming a part of the surface, it appears slaty rather than stratified; it varies in thickness, and, like the first stratum of this substance before described, it cuts off the veins of ore by dividing the Second and Third Limestone.

Third Limestone (h). This stratum is generally darker coloured than the second, and contains a portion of flinty chert; some of its beds are composed of different marine remains; in it are *patches* of Toadstone, independent of that stratum above or below it. This Limestone is of great thickness; it forms a considerable extent of surface, and contains numerous veins of Lead Ore, which are, as the former, abruptly intersected by

The *Third Toad Stone (i)*, which forms a stratum like the others before named, and with the same characters; its thickness varies, and in some cases, after sinking a hundred fathoms, it has not been cut through: it forms a considerable extent of surface in the mountainous districts, and rests upon the

Fourth Limestone (k). This stratum is the lowest of the Derbyshire series, and is supposed to rest on old red Sand Stone; it forms a considerable extent of surface in the north of Derbyshire; in it are many veins of Lead Ore, also deep fissures, and grand caverns: its beds are generally of greater thickness, and less variable than the preceding varieties; it has never been cut through; therefore it may be truly said, that we do not

know, or at least are doubtful, upon what substance it rests.

The Limestones of Derbyshire form beautiful Marbles, which are in great estimation, particularly those from Rucklowdale and Wetton, the latter having a porphyritic appearance, and the former exhibiting figures of Coral, Madrepore, Entrochi, &c.; but above all, the Black Marble is most precious: it is superior to any *now* found in Italy; its beautiful black rivals the antique, and it admits of so high a polish, as to reflect like a mirror, for which purpose it is sometimes used. It forms beautiful chimney pieces, slabs for tables, &c., and of it the most elegant vases are formed after the antique: the marble is so hard as to admit of being engraved, representing the figures of the Grecian and Roman Schools.

The finest of these various Marbles are from the mines and Quarries of the Duke of Devonshire, on whose princely estate are mills on a large scale, at Ashford *, for sawing and polishing, from whence the slabs are conveyed to Derby, where a most extensive assemblage of the finest chimney pieces and tables are on sale at *Mr. Brown's*, the proprietor of the establishment.

Collections, forming a series of Geological Specimens, from the uppermost Coal formation to the lowest Limestone, may be had at the *Museum* at Matlock, consisting of Thirty varieties, arranged and described, for One Guinea; or Fifty larger, and containing Specimens from the veins of Lead Ore, at Two Guineas. The

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* At Ashford is the Peak of Derbyshire.

finest Crystallizations of Calcareous Spar, Fluors, &c. at various prices.

The Geologist is particularly recommended to make Matlock his rendezvous for some days, as in its vicinity he will find such variety of strata, so many various productions, caverns easy of access, particularly the Rutland, in which the Toadstone appears: the mountain in which it is situated is called the Heights of Abraham, it is traversed in all directions by numerous veins of Lead Ore, one of which now appears as an open fissure on the left hand, on the side of the road going and near the High Tor, respecting which, and particulars relative to the Mineralogy of the neighbourhood, every information may be obtained at the Museum.

The beauties of the scenery at Matlock have been described by MOORE, an artist of great merit and ingenuity, who has published a small work, entitled, *Picturesque Excursions* in the neighbourhood of Matlock; it contains eight plates, and is expressly calculated to lead the artist to the most interesting situations for the employment of the pencil.

The pedestrian, about to make a mineralogical excursion, will do well to provide himself with a blow-pipe, a knife, containing forceps, file, and magnet, a small steel mortar, a pocket acid bottle, and a proper hammer; these are made so portable as not to be any incumbrance, and will be the means of affording amusement in the evenings, when he will examine what he has collected during the day; a little borax, as a flux, may be added, and then he will be tolerably complete.

Werner has classed the Metals and Earths in the following Order. The varieties belonging to each may be seen in any elementary work, or in the New Descriptive Catalogue.

CLASSIFICATION OF METALS.

Platina.		Tin.
Palladium.		Bismuth.
Irridium.		Tellurium.
Gold.		Antimony.
Mercury.		Molybdena.
Silver.		Nickel.
Copper.		Arsenic.
Iron.		Tungstein.
Manganese,	Not	Tantalum.
Titanium,	malleable.	Cerium.
Lead.		Cadmium.
Chrome.		Selenum.
Zinc.		Wodanum.

CLASSIFICATION OF EARTHY MINERALS.

These are arranged in what are called Families, and each are divided into Species and Sub-Species, comprising great Variety.

Diamond.	Azurestone.
Zircon.	Felspar.
Ruby.	Clay.
Schorl.	Clay Slate.
Garnet.	Mica.
Quartz.	Lithomarge.
Pitchstone.	Soapstone.
Zeolite.	Talc.

Hornblende.	Fluor.
Crysolite.	Gypsum.
Basalt.	Boracite.
Dolomite.	Baryte.
Limestone.	Strontian.
Apatite.	Hallite.

SALINE MINERALS—Earthy Salts.

Alum.	Epsom Salts.

ALKALINE SALTS—Salts of Soda.

Natron.	Rock Salt.
Sulphate of Soda.	Borax.
Reussite.	Native Boracic Acid.

SALTS OF AMMONIA.

Muriate of Ammonia.	Sulphate of Ammonia.

METALLIC SALTS.

Sulphate of Iron.	Sulphate of Copper.
Sulphate of Zinc.	Sulphate of Cobalt.

INFLAMMABLES.

Sulphur.	Graphite.
Bitumen.	Resin.
Coal.	Retin-Asphalt.

DESCRIPTION

OF THE

Portable Lapidaries' Apparatus,

BY WHICH

THE OPERATION OF CUTTING, POLISHING, AND SLITTING

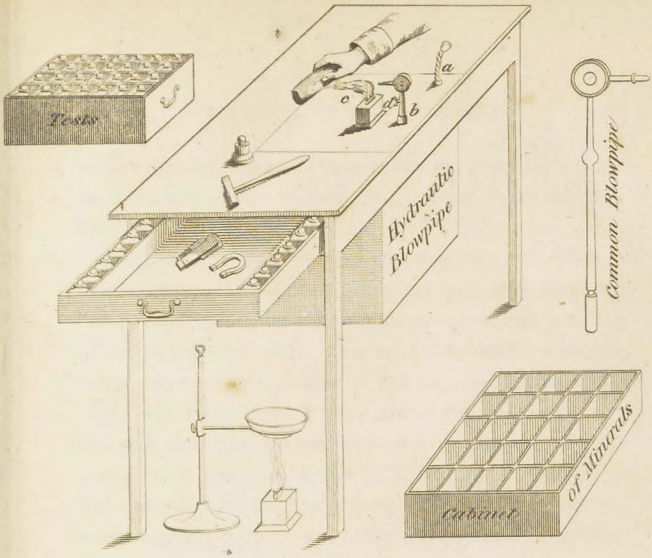
PEBBLES, AGATES, JASPERS, &c.

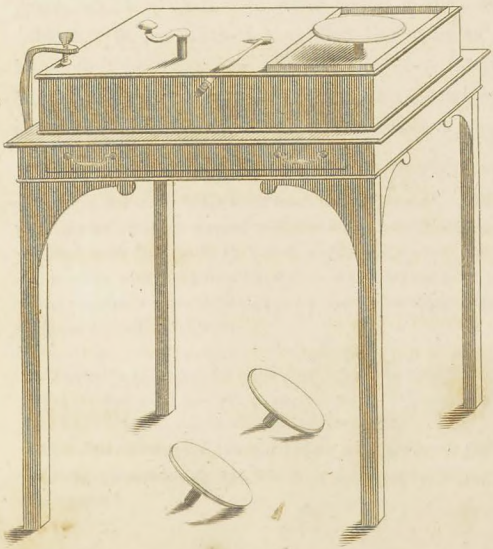
MAY BE PERFORMED.

THE agreeable amusement of collecting Pebbles, Jaspers, Agates, &c. has of late become so fashionable, that almost every one who visits the coast has been employed in searching for these pretty productions, and forming collections of them; but great disappointment has frequently taken place, owing to the want of a convenient method of cutting and polishing these beautiful substances. To obviate which, a Portable Apparatus has been contrived, so as to render the operation easy, and which will afford both instructive and agreeable employment.

This compact Lapidaries' Apparatus is contained in a small box, and may be placed on any parlour table: the method of using it is explained as follows, viz.

First, secure the box to the table (with the cramp) that it may be steady, and then it will be ready for work. A japanned tin pan, with a hole in the centre, accom-





New invented Lapidaries apparatus for slitting & polishing Agates &c.

panies the box, which is to prevent the operator's dress from receiving the water, &c. ejected from the mill when at work *.

Next put the tin pan over the spindle, and screw † on the lead-mill marked A, place the pot, with fine corn emery and water, in one of the corners, and with the brush charge the mill; then turn the handle with the left hand, resting the right on the edge of the pan, and apply the stone, taking care not to lay on too heavy; the mill works best when turned with considerable velocity, in which case it will be necessary frequently to dab the mill with the brush from the emery pot, and almost instantly a plane will be produced: in this manner facets are cut upon Amethysts, &c.; when the stone is sufficiently worn down the cutting mill is unscrewed, and the polishing mill, marked B, is screwed in its place, which is used with rotten-stone a little wet; the substance to be polished is applied the same as in cutting; if it be hard, it will soon receive a fine lustre; but if it be soft and porous, it will take more time; it is necessary to look frequently at it, in order to know how

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* There are six mills, one of lead, one of pewter, and a plate of soft iron for slitting—a wood mill, one covered with cloth, and one covered with list (soft) to polish shells, &c.; they are marked underneath with what substance they are to be used.

The spindle is spiral, that when the string becomes slack, it may be moved a pulley higher.

† The mills are screwed on and off by firmly holding the pulley within the box with the left hand, to prevent it turning, whilst the right hand screws or unscrews the mill wanted.

It is advisable for the learner to see a practitioner perform the different operations, as that would be a lesson worth a volume of description!

the polish proceeds; a few drops of water must be applied at intervals.

Some scrape the polishing mill with a case knife, or rather hold the edge of the knife lightly upon the face of the mill, and turn it gently round, which gives it a new surface, and causes it to hold the polishing material (rotten stone) better.

The Slitting Mill is more delicate than any of the preceding, and will require care, that it may run true on its centre. Many are not aware how a piece of Agate or Crystal can be cut into slices, being so much harder than the best tempered steel; for this purpose the Slitting Mill is made of a thin iron plate, the edge of which is armed or charged with Diamond dust *. The particles of Diamond soon become *set* in the iron plate, and form teeth; then, with a tolerable quick motion and copious supply of oil, it will cut (with management) whatever is applied to it.

When a stone is slit, and the marks worked out, by the lead mill, it should be washed, and applied to the wood mill with flour emery, or fine sand and water, before it is polished on the pewter mill; after which, and finally, the cloth or list mill may be resorted to, which will heighten the polish if necessary.

There is another mill to be used with coarse emery,

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* *Diamond* commonly called *Diamond bort*, must be reduced to powder in a mortar, then prepare about one-eighth of a grain by rubbing it with a few drops of oil upon a piece of Steel or Agate; after which it may be applied with the finger to the edge of the plate, or mill.

Diamond bort, either in the rough or pounded state, fit for use, may be bought at about 30s. per caret.

which will slit marble and soft substances, using milk instead of water; it is advisable the learner should make himself master of slitting soft stones of this sort, before he begins with Diamond powder.

These are the mills generally used; but to render this apparatus more complete and amusing, three others are added—one is covered with cloth, and is intended to be used with putty of Tin, and a little water. Marble, Spar, and other stones, that do not give fire with Steel, may be polished upon it.

The mill covered with list should be used as the preceding, with putty and water, to which a little soap may be added; it is useful in polishing substances with plain or uneven surfaces, as some varieties of shells, &c.

The plain wood-mill may be used with sand or fine emery and water; it is applicable to various purposes, as cleaning rusty Iron, rubbing down Marble, Spars, Gypsum, or Shells. Other mills may be added, with brushes or leather, for various uses.

Shells may be uncoated, to shew their pearly appearance, on the lead mill, with coarse emery; then, on the wood mill, with fine sand; and lastly, on the list mill, with putty, which will give them a beautiful polish.

Brush mills may be used to great advantage, either dry or wet.

If a piece of Clay is placed upon the lead, when upon its spindle, it will make an excellent potter's wheel, and cups or saucers may be raised at pleasure. It also forms a good substitute for the grindstone, and may with great ease be applied to many useful purposes.

It is not necessary to state that the tools should be kept in nice order, clean, and always ready for use.

Cat-gut strings, are commonly used, the ends screwed into a steel hook and eye; the inner ends are afterwards burnt with a red-hot wire or knitting needle, to prevent its drawing out; but I have found cotton strings less troublesome, and more easily applied.

The expence of this Apparatus, with emery, putty, &c. is from six to eight guineas, according as it is fitted up for various uses. Some are made as high as ten pounds. It is particularly recommended that those who purpose making use of them, should receive a lesson or two by way of instruction.

EXPLANATION

OF THE

HYDRAULIC BLOW-PIPE.

THE article of this name is a vessel made of tin plate, in the form of a parallelopipedon, which must be half filled with water. In it a partition is so placed, as to divide it into two chambers, having a vacancy at the bottom. A tube is placed in the corner *(a)*, that by blowing down it the water becomes displaced from one chamber into the other, which acts with such pressure through the vacancy, as to force a continued stream of air through the nozle *(b)*, which being directed across the flame of the lamp *(c)*, a jet of heat is produced equal to a forge. The mineral to be examined should be small, and placed on a piece of charcoal, then placed in contact with the point of the flame. By keeping the water at the highest elevation the air becomes more compressed and the greatest degree of heat is produced. The stream of air may be increased, diminished, or stopped, by turning the valve *(d)*. The plate shews the apparatus through the surface of a table, the drawer with chemical tests, mortar, hammer, magnet, &c.

The SMALL BLOW-PIPE * is a most useful instrument,

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* A small steel mortar is indispensable for the blow-pipe, to reduce substances, both before and after examination. A spirit

and though many varieties have been made, yet on the broad scale of real utility the mouth blow-pipe is the best. It is difficult to describe the knack of keeping a continued blast for a minute or two; it is acquired by a little practice, and every one can blow for a few seconds; one lesson on the mode of using it would be more satisfactory than any description: a violent heat may be produced in a few seconds, and if well managed, will melt, or be the means of determining almost all the metals, &c. without difficulty. It is so portable, so useful and instructive, that the traveller should not be without it.

It must *always* be understood, that the substance submitted to the flame must be small, not larger than a pepper corn; disappointment frequently occurs from attempting to melt larger particles.

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lamp is useful, as it emits flame without smoke; a good magnet to detect iron.

The New Descriptive Catalogue explains the effect of the blow-pipe, upon the different substances.

THE END.

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HARNARD AND FARLEY,
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